The American Journal of Surgery

NEW SERIES, VOL. XVI MAY, 1932 No. 2

DIFFERENTIAL DIAGNOSIS OF

LESIONS IN & ADJACENT TO THE SELLA TURCICA*

CHARLES H. FRAZIER, M.D., SC.D.

PHILADELPHIA

IN our files in the Neurosurgical Clinic of the University Hospital are 368 cases originating in the pituitary body and structures immediately adjacent. In the early days of the surgery of pituitary lesions we were wont to think mostly of the intrasellar adenoma, representing as it does unquestionably the most frequent of all lesions in this territory. As time progressed our attention was drawn to many other tumors which, because of their juxtaposition to the sella turcica gave rise to endocrine symptoms of pituitary origin and to structural changes in the bony processes of the pituitary fossa.

The most satisfactory classification of the lesions under consideration is based upon the pathological histology of the lesion in question. Upon this basis we will include in our discussion of the differential diagnosis supported by illustrative cases, the following:

I. Intrasellar adenoma
II. Suprasellar adenoma
III. Adenocarcinoma
IV. Malignant adenoma
V. Adamantinoma
VI. Teratoma
VII. Ganglioneuroma
VIII. Suprasellar arachnitis (pseudotumor).
IX. Suprasellar fibroblastoma.

I. INTRASELLAR ADENOMA

Speaking first of the intrasellar adenomata, we have observed an extraordinary variation in the clinical syndrome and the cases naturally group themselves into subdivisions: (1) those with outstanding endocrine symptoms but without visual disturbances; (2) those conspicuous for their field distortions and loss of visual acuity with little if any evidence of endocrine disorders, and (3) those in which both visual disorders and endocrine dysfunction are equally represented. The majority of patients are over thirty years of age, a small minority have intense headache of the pituitary type, in some there is the picture of acromegaly, in others of the Fröhlich syndrome or perhaps a combination of the two. With occasional exceptions as in the suprasellar type there is the unfailing ballooning of the sella turcica, an unmistakable expansion of the sella in both vertical and anteroposterior diameters at the expense of the sphenoid sinus. The roentgenogram of the primary pituitary lesion admits of but one interpretation and, with notable exceptions, the diagnosis of an intrasellar adenoma may be made upon the roentgenogram alone. When the vertical diameter is decidedly

* From the Neurosurgical Clinic of the University Hospital, Philadelphia, Pa. Submitted for publication February 2, 1932.

increased as it should be a line drawn from the tip of the ear to the nasal spine always passes through the plane of the sellar floor. (Fig. 2.) When the vertical diameter is not increased appreciably this projected line will pass below the sellar floor. (Fig. 3.) In our series of primary pituitary adenomata, intrasellar, the average age was thirty-four, 40 per cent were females and 60 per cent males. In 75 per cent there was a bitemporal hemianopsia, in 10 per cent an homonymous hemianopsia, 12 per cent were already blind in one eye.

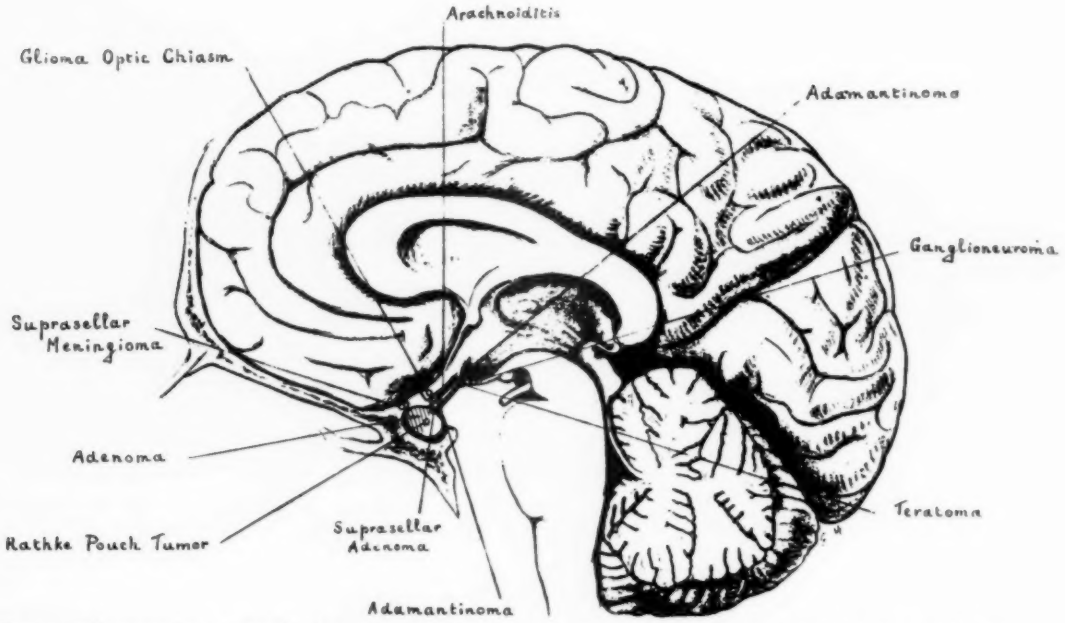


Fig. 1. Diagrammatic sketch showing position of various types of lesions in and about optic chiasm.

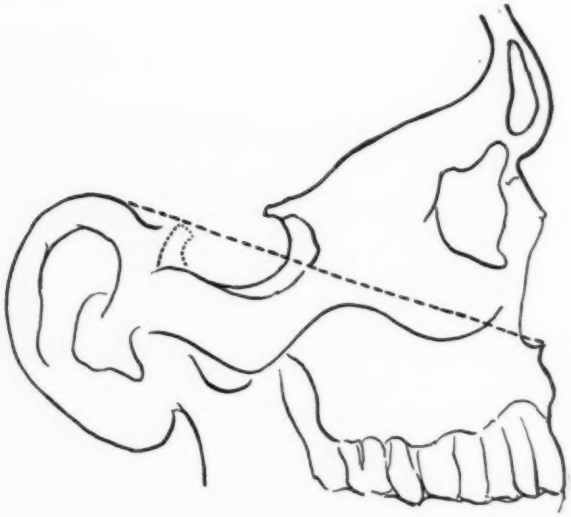


Fig. 2. Diagrammatic sketch to illustrate relation of line drawn from nasal spine to tip of ear. When vertical diameter of pituitary fossa is increased as in pituitary adenomata this line passes through fossa.

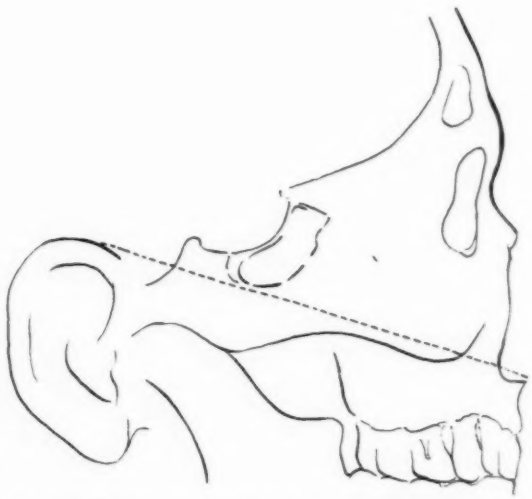


Fig. 3. Diagrammatic sketch to illustrate relation of line drawn from nasal spine to tip of ear. When vertical diameter of pituitary fossa is not increased this line passes below fossa.

Case 1. *Summary.* A typical case of pituitary adenoma in a male subject twenty-five years of age, operated upon by

the transphenoidal route; seven years after the operation the patient is symptom free and fields are full.

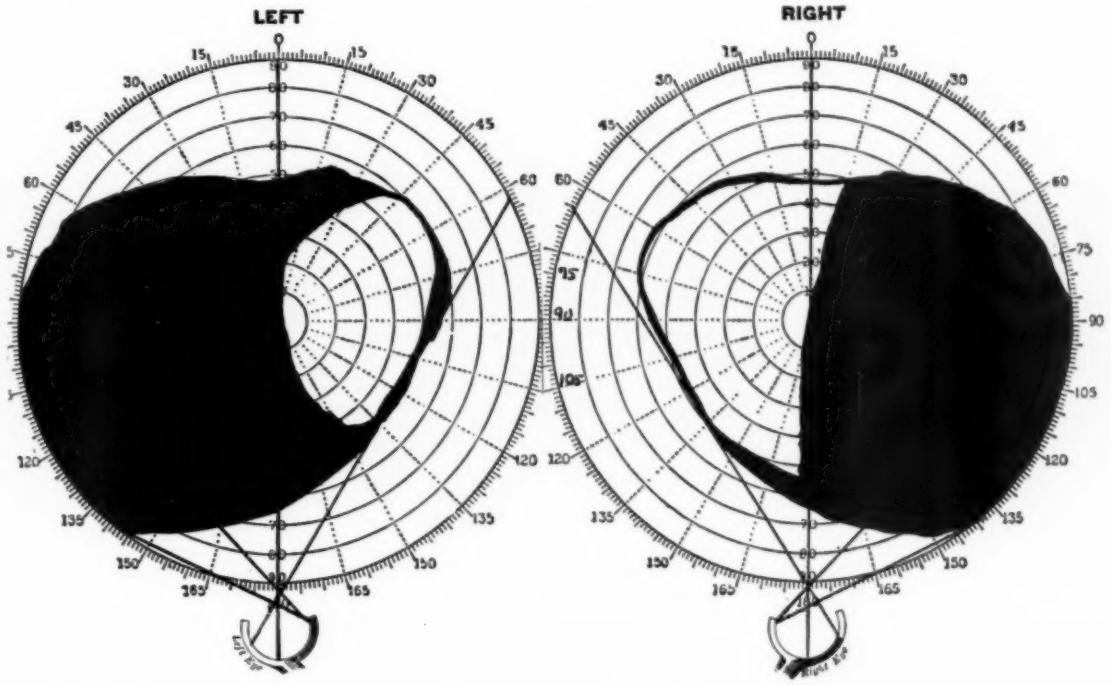


Fig. 4. Case 1. Fields before operations.

Case 1. O. G. L. a male, aet. twenty-eight years, File No. 2279 N. S. was referred by Dr. G. E. deSchweinitz to the Neurosurgical Service of the University Hospital October 27, 1923, complaining chiefly of headache and failing vision.

History. Two years ago, 1921, began to have terrific frontal headaches about once a week. June 1922 and on several occasions afterward, he had diplopia. He has complained lately of polyuria and polydipsia and lately has gained 20 pounds in weight.

Examination. There were no unusual findings except those which related to the pituitary lesion.

Endocrine Disturbances. Polydipsia, polyuria, basal metabolism minus 30, accession in weight, impotence.

Ocular Disturbances. Bitemporal hemianopsia, vision O. D. 4/15 O. S. 4/12. (Fig. 4.)

Pressure Phenomena. Violent headache.

Roentgenogram. Sella turcica 15 × 17 mm. (Fig. 5.)

Operation. Transphenoidal hypophysectomy November 6, 1923. By the usual technique the nasal septum was resected, the sphenoid sinus opened and found to be more capacious than is usually the case in pituitary operations. Sellar floor was about twice as thick as an egg shell. After its penetration and removal the capsule was split and soft gelatinous material was evacuated with a curet,

Fig. 5. Case 1. Deformation of sella, moderate enlargement, measurements A.P. 15 mm. depth 17 mm.

the cavity was swabbed with 3 per cent iodine solution, the operation discontinued and the wound closed. (Fig. 6.)

Fig. 6. Case 1. Incision now used for transfrontal craniotomy, beginning 1 inch below hair line of forehead, extending posteriorly to just above ear.

Fourteen days after operation the patient's fields were practically normal. (Fig. 7.)

Pathological Diagnosis. Adenoma.

Postoperative Notes. The patient has been followed from time to time. When last seen in October, 1930, seven years after his operation, there was no evidence of recurrence.

II. SUPRASELLAR ADENOMA

As exceptions to the characteristic features of the primary adenomata, mention should be made of the suprasellar adenomata. (Fig. 8.) They may differ in no respects from the primary intrasellar adenomata other than in the absence of the characteristic ballooning of the sella. The field distortion is the same, bitemporal hemianopsia, and, they may, as in the case to be cited, or they may not exhibit endocrine disturbances. The extension upward rather than downward of the growth may be due to an unusually large foramen or to very loose texture of the diaphragma sellae. While the sella may not be deepened, the dorsum sella may be eroded and even as in our case, disappear. In this respect they resemble the suprasellar fibroblastomata. The latter as a rule occur at a later period than the adenomata. (Fig. 9.)

Case II. *Summary.* A suprasellar adenoma in a middle-aged physician, without endocrine disturbance, without deepening of the sella, with a bitemporal hemianopsia and visual hallucinations, is actively engaged in his profession four years after the operation. (Fig. 10.)

Case II. W. J. K. aet. forty-eight years, File No. 4544 N.S. was admitted to the Neurosurgical Service of the University Hospital November 22, 1924, complaining chiefly of failing vision.

History. Being a sportsman and fond of shooting, the patient noticed for the past five years his eye sight was failing. He had had his tonsils and one tooth removed and his sinuses *x*-rayed, hoping to remove any septic focus. For the past six months his vision rapidly deteriorated and he noticed he could not see objects in his temporal fields. For the past three months he has not been able to read fine print. There is some diplopia for distant vision and occasionally on the right side he sees white flashes of light. As a physician he has continued his practice up to the present time.

Examination. A thorough physical and neurological examination revealed no abnormalities relating to the pituitary body. He had not gained weight, he had no headache, there were no suggestions of acromegaly nor of any endocrine disturbance.

Ocular Disturbances. There was a bitemporal hemianopsia.

Roentgenogram. There was no depression of the floor of the sella but the dorsum sella had practically disappeared. (Fig. 11.)

Operation. Transfrontal craniotomy, right. Local anesthesia. Elevation of frontal lobe under the protection of cotton tampons. The right optic nerve was carefully isolated from the capsule, the capsule opened and its contents removed. The contents were partly

solid and partly fluid and when removed all signs of pressure had disappeared.

Pathological Diagnosis. Adenoma.

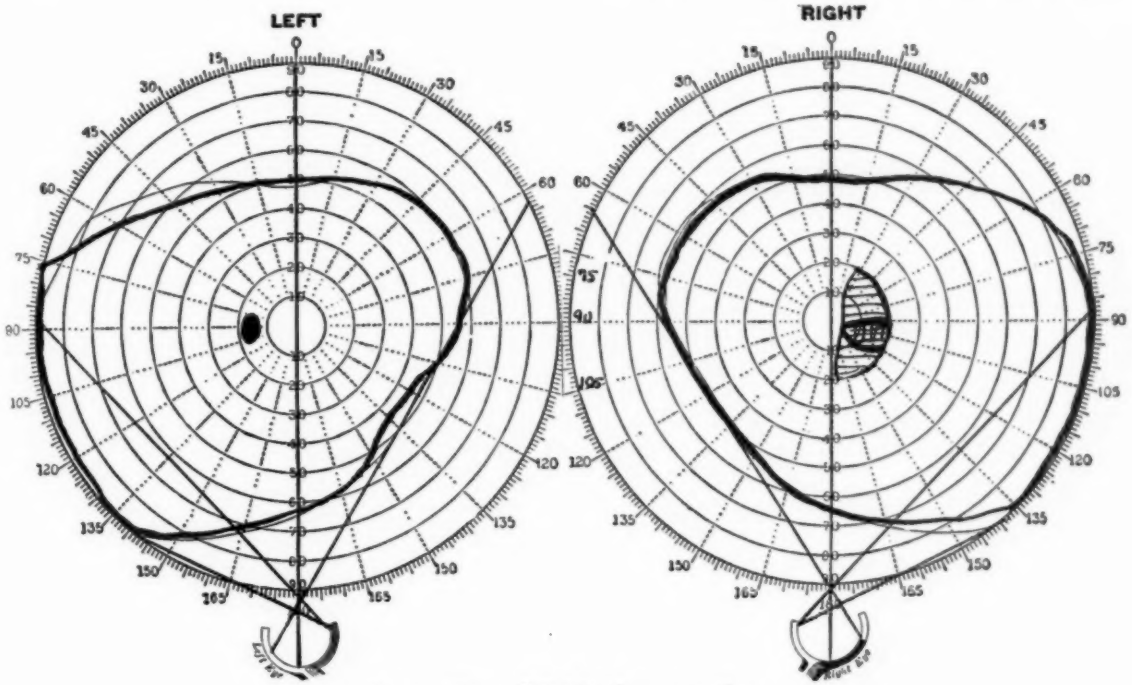


FIG. 7. Case 1. Fields after operation.

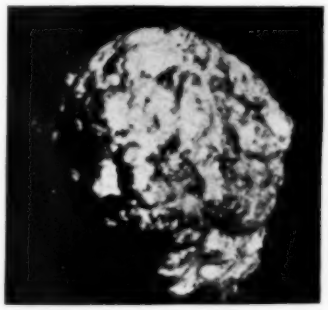


FIG. 8. Photograph of suprasellar adenoma.

Postoperative Note. The patient was discharged December 28, 1924 and was last heard from January 13, 1932, eight years after the operation when he wrote: "I am very well, working every day and have not suffered any inconvenience since the operation."

III. ADENOCARCINOMA

Included among the tumors which at some stage present the characteristics of an intrasellar tumor are the adenocarcinomata. In my series of verified adenomata and adenocarcinomata the incidence is in the proportion of 7 to 1. As there are many other clinically classified adenomata without pathological identification, this

FIG. 9. Size and position of suprasellar adenoma.

proportion appears relatively large. It is in the early stage of the adenocarcinoma that confusion in diagnosis may readily

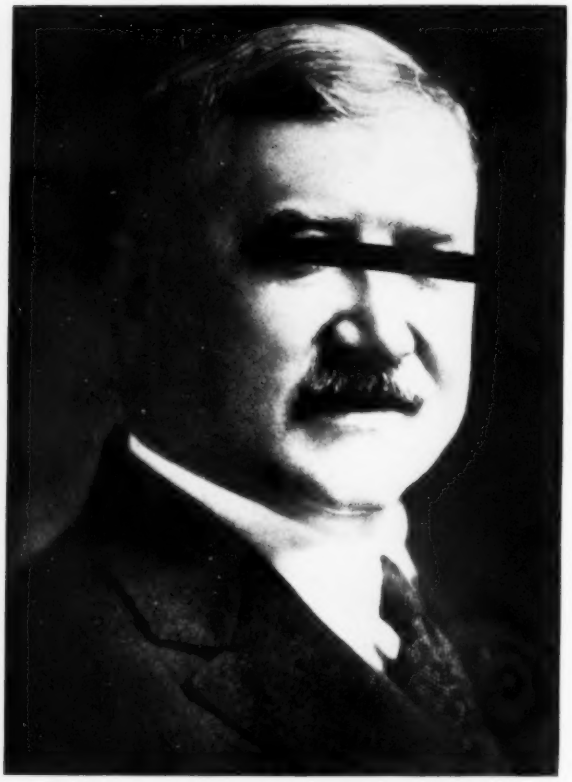


Fig. 10. Case II. Photograph of patient.

arise; originating as it does in the anterior lobe, the tumor may present all the earmarks of the benign adenoma. Illustrative of this stage is the following case:

Case III. *Summary.* An intrasellar growth in a male of middle life, with failing vision, hemianopsia, primary optic atrophy and headaches. Pressure temporarily relieved by evacuation of the sellar contents by the transphenoidal route. The tumor proved to be an adenocarcinoma.

Case III. V. M. male, aet. forty-nine years, File No. 65176, was admitted to the Neurosurgical Service of the University Hospital July 15, 1921, complaining of dimness of vision.

History. Three years ago the left eye was injured in an accident. His vision in this eye was somewhat damaged but a year and a half later it was noticed that the sight in both eyes was affected and progressively failing. Six months ago he noticed he could not see objects on either side without turning his head. Three months ago he could read only large type. He

Fig. 11. Case II. Complete atrophy of dorsum sellae without depression of sellar floor or encroachment on sphenoid sinus.

had occasional headaches and occasional attacks of vertigo.

Examination. The patient was somewhat emaciated but in other respects with the exception of vision there was no evidence of any physical disability.

Endocrine Disturbances. None.

Ocular Disturbances. Vision O.D. 5/10, O. S. 5/20. Optic nerves pale with shallow atrophic excavation. Fields showed a bitemporal hemianopsia. (Fig. 12.)

Roentgenogram. Pituitary growth. Measurements A. P. 13 mm. depth 10 mm. (Fig. 13.)

Blood Sugar. Before administration of 100 gm. glucose .067, one hour afterward .265, two hours .092, three hours .060.

Operation. Transphenoidal hypophysectomy, July 20, 1921. Ether anesthesia. The floor of the sella was still intact although so thin that it could readily be penetrated with the sharp end of the probe. When the floor was removed the capsule of the tumor was exposed. Upon incision of the capsule hemorrhage was profuse, the tumor was extremely vascular. The contents were removed with curet and forceps. The operation was uncomplicated. The wound was closed with deep and superficial sutures and the nares tamponed.

Pathological Diagnosis. Adenocarcinoma.

Postoperative Note. The patient recovered from the immediate effects of the operation but several months later gradually became more and more stuporous and died December 11, 1921. Permission was granted for the removal of the brain and the physical characteristics of the tumor and reproduced in the illustration. (Fig. 14.)

There was a moderate suprasellar extension of the growth, but en masse it was not much larger than the dimensions of some cases of benign adenomata. The cause of death was undetermined. Certainly there are other cases of adenocarcinomata attaining much larger proportions and still consistent with life.

If this case represents a comparatively early stage of the adenocarcinoma others might be cited to illustrate the tendency of these tumors to attain enormous proportions and spread far beyond the confines of the sella turcica. One of these will suffice as an illustration.

Case IV. *Summary.* An adenocarcinoma arising in the pituitary fossa with involvement of III, V, VI, VII, IX, X and XII cranial nerves; extension into the posterior ethmoid and sphenoid sinuses, left orbit, pharynx, nares and posterior fossa.

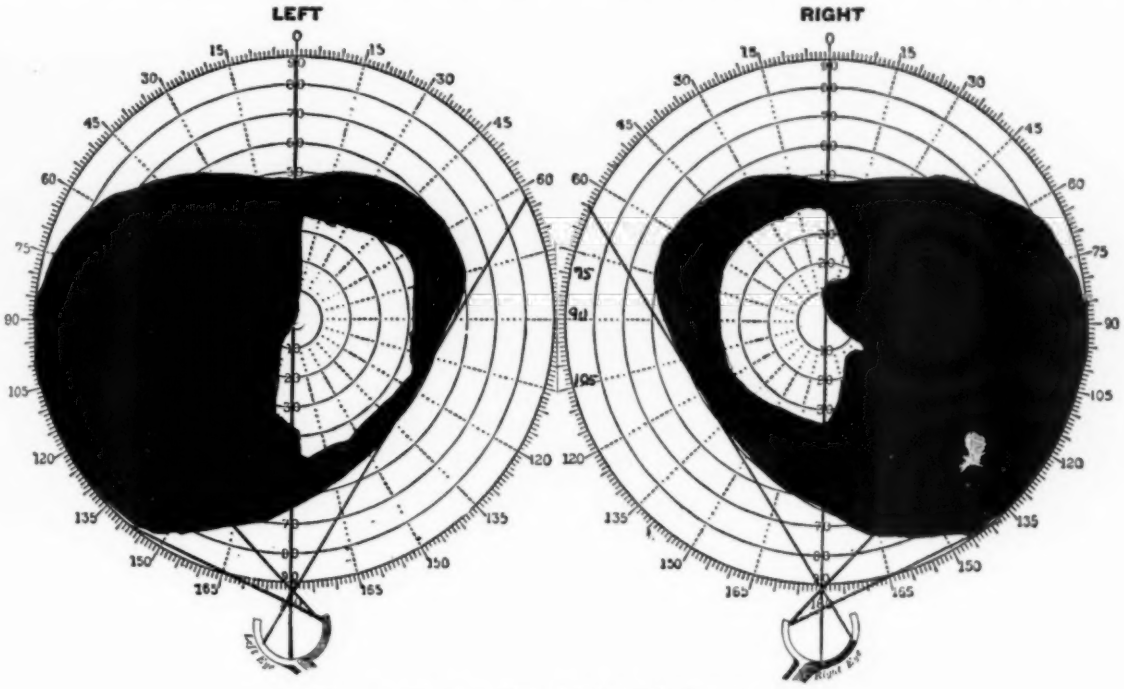


FIG. 12. Case III. Visual fields before operation.

FIG. 13. Case III. Ballooning of sella turcica characteristic of pituitary adenomata.

CASE IV. A. B. male, aet. forty-seven years, File No. 17294, was admitted to the Neurosurgical Service of the University Hospital October 29, 1929, complaining of left-sided facial pain, and diplopia.

History. Until five months ago the patient was perfectly well. May 28, 1927, he noticed diplopia on looking to the left. Four months

ago eight teeth were extracted. Soon after he complained of pain first in the mandibular, then in the maxillary and finally in the ophthal-

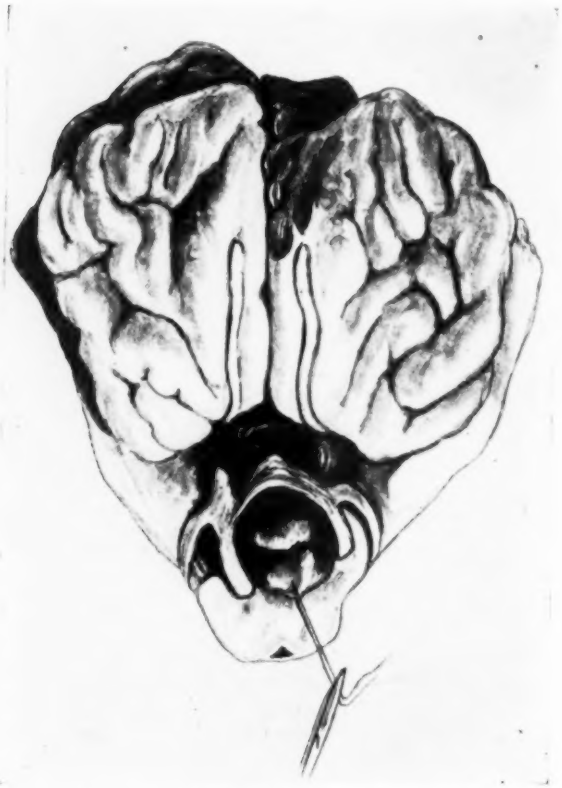


Fig. 14. Case III. Drawing of tumor showing relationship to optic chiasm and optic nerves.

mic division of the left trigeminus. The pain, which has increased in severity especially in the malar and temporal regions, is described as burning with knife-like exacerbations, a lightning hot pain. There is hyperesthesia in the left temporal region and below a sense of tingling. The left side of the face has been swollen, with weakness for the past four months.

Examination. A middle-aged man, who appears sick, is somewhat stuporous and difficult to arouse. There are no paralyses except of the face. The biceps, triceps, patellar and Achilles tendon reflexes are exaggerated on both sides. There is a positive ankle clonus on the right side.

Cranial Nerves. III, Drooping of the left eyelid. V, The jaw deviates to the left on opening the mouth. There is anesthesit to touch and paroxysmal pain in the left trigeminal distribution. (Fig. 15.) VI, Diplopia on looking to the left. VII, The left side of the face is flattened, cannot chew on left side, although he wrinkles forehead on both sides. IX, Sensation on left side of pharynx impaired,

Fig. 15. Case IV. Chart showing area of sensory disturbance in trigeminal distribution.

difficulty in swallowing. X, Palatal and pharyngeal reflexes absent on left. XII, Protrudes tongue to left.

Pharynx. Examination of pharynx reveals a tumor somewhat resembling a pharyngeal tonsil. Presumably extension of tumor through basilar process of sphenoid sinus.

Pituitary Stigmata. Loss of libido.

Ocular Phenomena. Vision unimpaired. Discs, waxy yellow. Diplopia on looking to left, horizontal nystagmus on looking to right. Fields, normal. Vision O. D. and O.S. 20/20.

Roentgenogram. Evidence of destructive growth in pituitary fossa. Complete disappearance of dorsum sella. Clouding of sphenoid and posterior ethmoid sinuses. (Fig. 16.)

Cerebrospinal Fluid. Pressure 220 mm. Protein 3.5 units 52 lymphocytes.

Operation. Exploratory craniotomy and subtemporal decompression November 4, 1929. Ether anesthesia, colonic. An exploratory operation was contemplated but by the time the olfactory groove was seen the patient's condition was such that it did not seem wise to continue. Sufficient bone was removed from beneath the temporal muscle for decompressive purposes and the wound was closed.

During the convalescent period the pain in the trigeminal distribution was so intense an alcoholic injection was given. The patient developed a corneal ulcer in the left eye. At times he was confused. He was given repeated doses of 50 per cent glucose. December 7, 1929, the patient could not swallow. December 10, 1929 he was at times stuporous, at times mentally confused. He was discharged from the hospital December 12, 1929.

Fig. 16. Case IV. Evidence of destructive growth in pituitary fossa. Complete disappearance of dorsum sellae. Clouding of sphenoid and posterior ethmoid sinuses.

The patient died soon after his return home. At the autopsy a large tumor was found arising in the pituitary body but extending in every direction. The cribriform plate and posterior ethmoid cells were practically destroyed. The central part of the sphenoid was entirely replaced with tumor. The central part of the tumor was composed of soft tissue but around the margins were tiny trabeculae of bone. The tumor was not sharply demarcated and could not be entirely removed. It had perforated the left orbit. There was an extension 3 cm. in length into the posterior fossa compressing the left cerebellar hemisphere. The tumor had invaded the pharynx and nares. (Fig. 17.)

Fig. 17. Case IV. Photograph of tumor.

This description of the invasion of structures far beyond the confines of the sella turcica might be said to be characteristic of the adenocarcinoma. The tumor invades adjacent sinuses, sphenoid and ethmoid sinuses, may send extensions into the middle fossa and in one of our series there was so large an extension in the posterior fossa that the outstanding symptoms were those of cerebellar dysfunction. Unlike the benign adenomata the adenocarcinomata involve the cranial nerves that flank the sella turcica. Thus in the early stages hypesthesia in the trigeminal distribution and later pain or paralysis of the oculomotor or trochlear bespeak the tendency of the tumor to extend beyond the confines of the pituitary fossa. Possibly because of its destructive character, as it eats its way into the sinus or orbit, the tumor may attain large proportions without causing alarming signs of intracranial pressure. The erosive action of the tumor at the base of the skull, its infiltrating character, its lack of encapsulation possibly accounts for the fact that pressure is not exerted upon the third ventricle and the signs of a ventricular block, headache vomiting and papilledema may be conspicuous by their absence.

At all events the invasion of structures beyond the bounds of the pituitary fossa

is the striking characteristic of the adenocarcinoma. When, therefore, the roentgenogram reveals destruction of dorsum sellae,

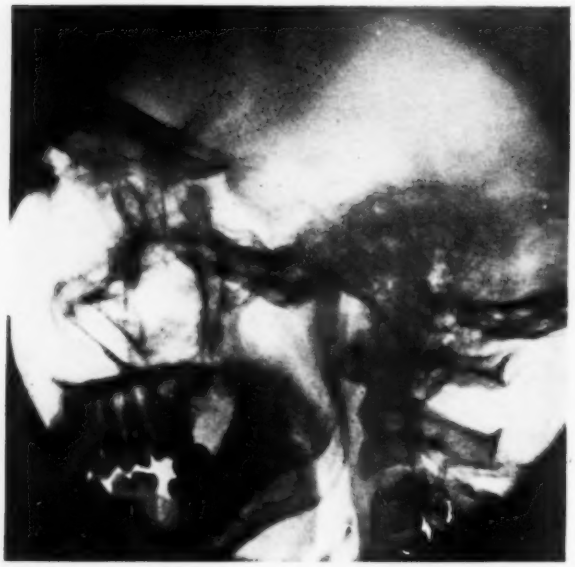


Fig. 18. Case v. Pituitary fossa only moderately enlarged. A.P. measurement 15 mm. Stereoscopic view showing depth 9 mm. on left, 13 mm. on right side.

clouding of the sinuses, perhaps erosion of the petrous bone, when there are signs of involvement of the third, fourth or fifth cranial nerves with or without signs of cerebellar disturbance, one may postulate with reasonable assurance an adenocarcinoma.

IV. MALIGNANT ADENOMA

Case v. *Summary.* A large malignant adenoma, mostly extrasellar, in a young woman with symptoms of only a few weeks' duration.

Case v. M. T. female, aet. nineteen years, File No. 20497 was admitted to the Neurosurgical Service of the University Hospital October 18, 1930, complaining of headache, failure of vision and projectile vomiting.

History. September 10, 1930 only three weeks ago the patient began to complain of temporal headaches and projectile vomiting. One week later her vision began to fail and in another week her temporal fields were lost. At the present time she can see nothing with the right eye and objects at 5 inches with the left. She complains of an area of localized tenderness on the right side of the head from which her headaches radiate to the occiput.

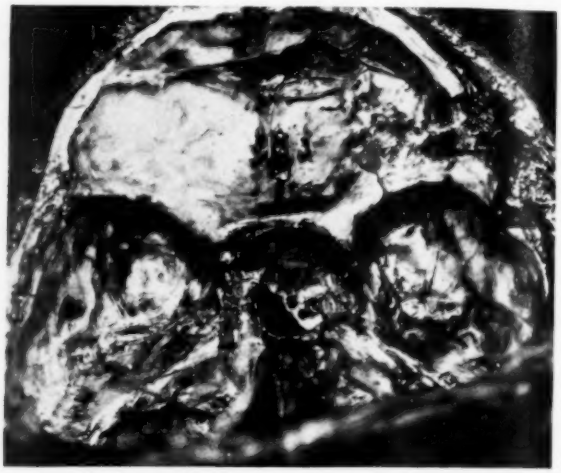


Fig. 19. Case v. Skull, showing erosion of floor of pituitary fossa.

Two weeks ago she had vertigo and tinnitus aurium. She menstruated only once in her fourteenth year and never since then.

Examination. A stolid fat young woman of foreign birth; head broad with low forehead and high cheek bones. The patient is uncooperative and her attention poor. There is weakness of both the left upper and lower extremity and a left facial weakness of central origin. The left abdominal and patellar reflexes are exaggerated with a positive left Babinski.

Pituitary Stigmata. Amenorrhea of five years' duration. Some accession in weight. Obesity.

Ocular Disturbances. Vision O. D. blind. O.S. can count fingers at 5 inches on nasal side. Temporal hemianopsia. Optic atrophy appears of secondary type.

Roentgenogram. Pituitary fossa enlarged. A.P. 15 mm. depth 9 mm. on the left and 13 mm. on the right side. (Fig. 18.)

Pressure Phenomena. Frontal and bitemporal headaches with projectile vomiting. Secondary optic atrophy.

Cerebrospinal Fluid. Pressure normal.

Operation. Transfrontal craniotomy, right. October 30, 1930. Colonic anesthesia. Upon reflection of osteoplastic flap the tension of dura was not found abnormal. A ventricular tap recovered only a few drops of fluid. No hydrocephalus. The frontal lobe was elevated with difficulty. One saw first the right optic

nerve and adjacent portion of the chiasm tightly stretched and flattened out over the tumor. At best one could not see more than a small surface of the tumor, possibly a square centimeter. An aspirating needle failed to recover fluid. Any thought of dealing radically with the tumor had to be abandoned. A small section was removed for histological study.

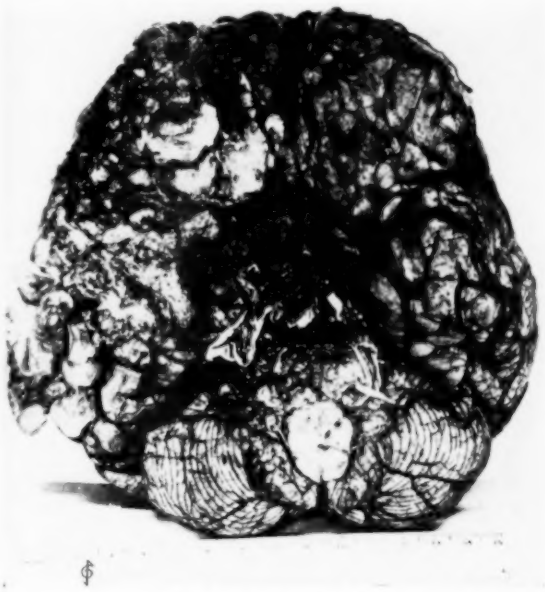


Fig. 20. Case v. Brain, showing malignant adenoma in situ.

We were of the impression that the tumor was mostly retrochiasmal, pushing the chiasm forward as a pharyngeal duct tumor. Throughout the operation the patient's condition was excellent, systolic pressure varied from 112–140, the pulse 80 to 120 and the respirations 18–20.

Postoperative Note. At 4 A.M. on the morning following the operation the temperature rose suddenly to 104°F. At 7 A.M. the lungs became edematous, at noon the patient died.

Pathological Report. At autopsy the brain was removed. The tumor measured 6.5 cm. long and 3.5 cm. wide, and 2.5 cm. thick. It filled the entire base of the brain from the olfactory gyrus to the pons. It was asymmetrical, longer on the right side on which side it encroached upon the cerebral structures. The tumor had excavated the base of the skull and perforated the right sphenoid sinus. (Fig. 19.) Both the right oculomotor and the right trochlear nerves were compressed. The tumor itself had a lobulated appearance, looked like a bunch of grapes, was of a reddish color and encapsulated. It was joined to the tela choriodea and adherent to the tentorium cerebelli.

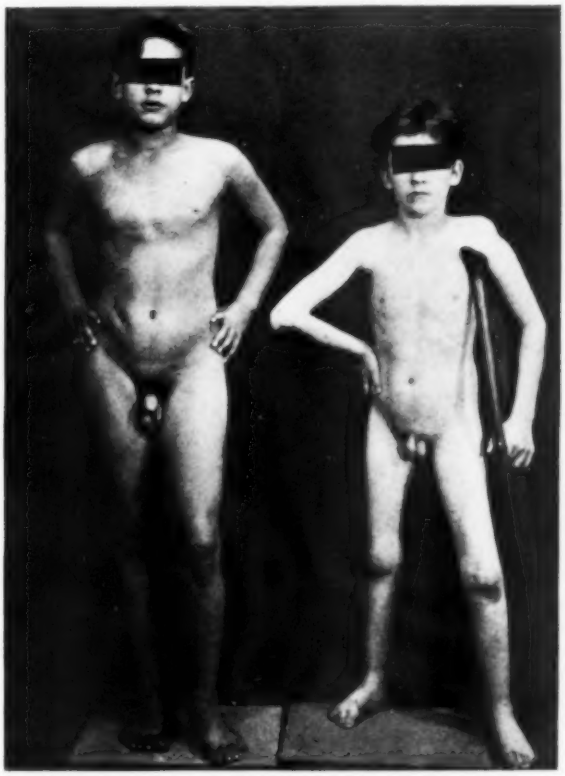


Fig. 21. Case vi. Patient fifteen years of age taken with average boy of twelve years, left.

It lay in a thick maze of blood vessels, some from the sylvian fissure, some from the base of the brain, some from the right occipital lobe. The vessels penetrating beneath the tumor were large and numerous.

On section the tumor was filled with blood. Fibrous septa divided the tumor into compartments. Small cysts were seen in the tumor mass. The pituitary itself could not be identified. On section the brain appeared markedly compressed at the base. There was marked distortion of the right side with resultant compression of the pallida and internal capsule of the right corpus mammillare and thalamus. The entire floor of the third ventricle was compressed and distorted. The right cerebral peduncle and pons also were compressed. Here the tumor was in direct connection with the tela choriodea of the inferior horn of the right lateral ventricle and seemed to form part of the capsule. (Fig. 20.)

Histologically the tumor appeared to be a malignant adenoma, largely extrasellar.

Discussion. From the standpoint of diagnosis this case presented many points of interest. The *x*-ray findings were most unusual, in fact, quite unique in our pituitary series in that the sella turcica was asymmetrical with a depth on one side of 9 mm. and on the other of 13 mm. one below normal and the other but a little above. It was evident that we were not dealing with a primary intrasellar adenoma and there was every reason to believe because of the hemiparesis that the tumor had extended beyond the limits of the sella. Was it a pharyngeal duct tumor? The patient was young but there was no calcification.

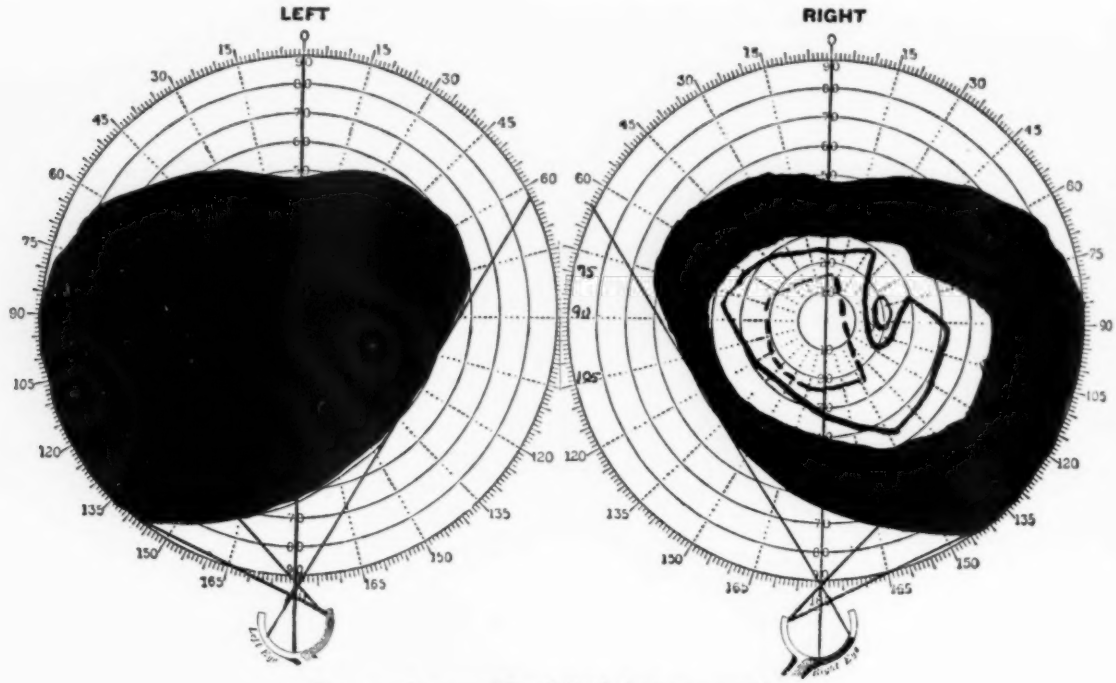


FIG. 22. Case VI. Visual fields before operation.

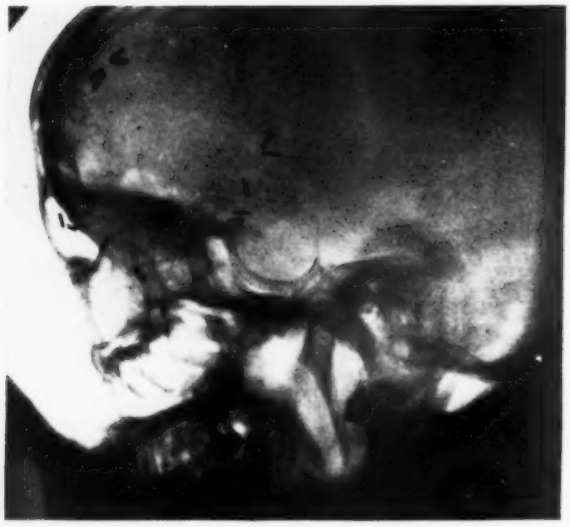


FIG. 23. Case VI. Roentgenogram showing pituitary fossa of enormous dimensions. A.P. measurement 23 mm. Vertical 19 mm.

The duration of the symptoms was a matter of surprise after the size of the tumor was revealed. To be sure the patient had amenorrhea for five years, which of course had to be taken into consideration, but the symptoms of pressure, hemianopsia, vomiting and headache were of less than a month's duration. Although the third ventricle was compressed we were surprised to find no evidence of hydrocephalus.

The signs of secondary optic atrophy suggested an earlier papilledema which had disappeared. What was the origin of the tumor? Did it arise from an extrasellar anlage or did it arise within the sella and escape through foramen of the diaphragm? Because of the absence of any trace of the pituitary body in the tumor mass, Dr. Alpers was inclined to accept the latter

interpretation. Had the mass arisen outside the sella in the infundibular stalk, one would have expected to find a compressed

Fig. 24. Case vi. Photograph of patient after operation showing incision formerly used for transfrontal operations and since abandoned. (See Fig. 6. Case i.)

pituitary gland. The presence of a ganglion within the tumor mass suggested extrasellar origin. It may have arisen from the pharyngeal hypophysis and involved the sphenopalatine ganglion in its course.

Extrasellar tumors which invade the interpeduncular space are well known to give rise to motor symptoms. In this case, however, the hemiparesis was readily explained by the marked compression of the structure in the right hemisphere, including the internal capsule, the pallidum, the corpus mammillare and the thalamus.

Within eighteen hours the patient developed hypothermia, pulmonary edema and died. There is no doubt a heat-regulating center in the infundibulo-tuberian region and the hypothermia which occasionally and as in this case, follow operations may be easily accounted for by trauma in the region of this heat center incidental to the manouevers of the operation.

The pulmonary complications may be

Fig. 25. Case vii. Photograph of patient.

accounted for in this case by the marked evidence of a foraminal hernia.

The tumor in this case was manifestly inoperable. One must recognize in this zone certain insuperable obstacles and these are particularly encountered in the extrasellar and especially in the pharyngeal duct tumors.

V. ADAMANTINOMA

Of the various types of tumors which enter into discussion, in the diagnosis of pituitary lesions, we must include the adamantinoma. It must be remembered that these tumors arise from embryonal epithelial rests of which there are two. The craniopharyngeal duct is an embryonal structure and these epithelial rests may be found low down in close relation with the anterior lobe of the pituitary body or higher in juxtaposition to the third ventricle. The different pictures that may be revealed according to whether the tumor originates in one or the other of these anlage are quite obvious. The identification of the tumor before the operation may present many difficulties in fact may be wholly impossible. There may be variations in the location of the lesion from the third ventricle above to the pituitary fossa below. There are extreme variations in the field distortions, there is wide discrepancy in the age of the patient from early childhood to middle age. In some cases the duration of symptoms may be a matter of months, in others a matter of years. It is said that these tumors predominate in children and young adolescents, but as a matter of fact in a series of 14 cases reported from our Clinic,[1] 2 were in the third decade, 2 in the fourth and one in the fifth.

FIG. 26. Case VII. Sella turcica of normal dimensions.

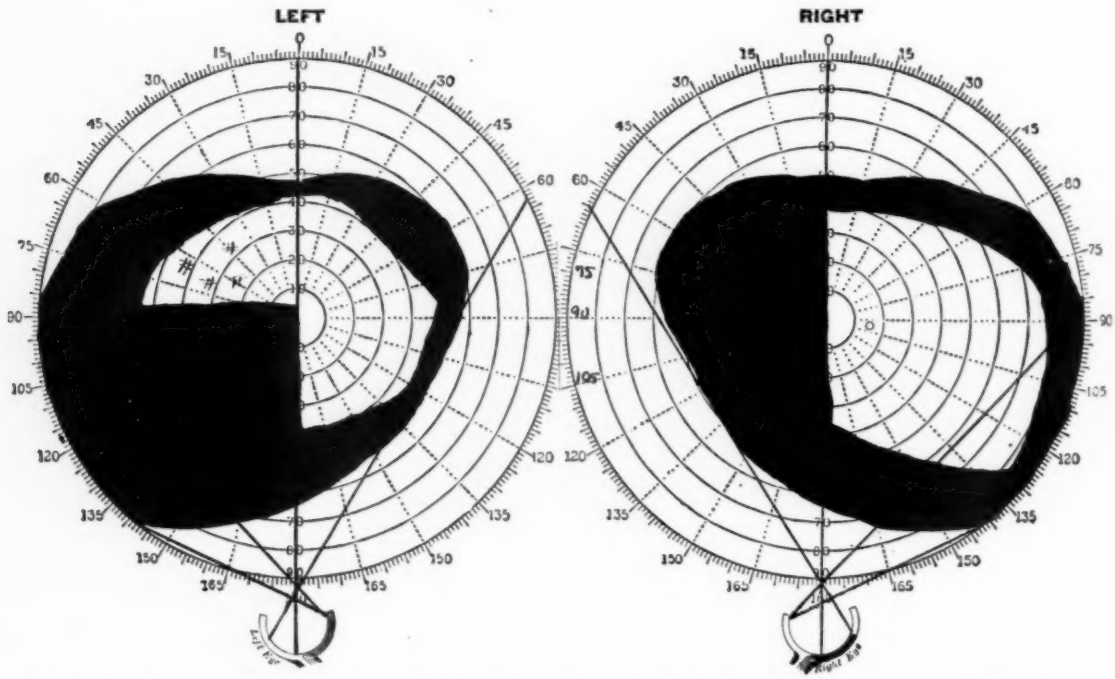


FIG. 27. Case VII. Fields: left homonymous hemianopsia which developed late in course of illness.

[1] *Arch. Neurol. & Psychiat.*, 26: 905, 1931.

The endocrine picture in this series was uniform in this respect that neither acromegaly nor gigantism were represented.

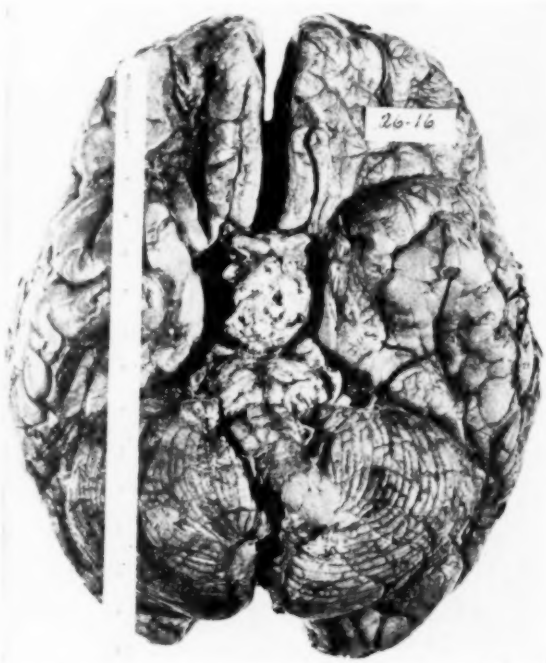


Fig. 28. Case vii. Base of brain showing retrochiasmal adamantinoma.

Dwarfism, somnolence, adiposity, regressive sex characteristics, femininity and polyuria predominated. As one might expect arrest of growth is the commonest endocrine disturbance.

The fact that the metabolic rate was, when recorded, always minus is of no diagnostic significance since in by far the majority of intrasellar adenomata the metabolic rate is below normal.

Increased intracranial pressure, when it implies obstruction of the third and lateral ventricles, is an important diagnostic feature as differentiating the primary pituitary adenomata from the pharyngeal duct lesions, such as the adamantinomata. Headache and vomiting, papilloedema and secondary optic atrophy, though present in only half of our series of adamantinoma, are never observed in the purely intrasellar adenomata.

As illustrating the extreme variations in the clinical picture of the adamantinomata the following cases are presented in abstract.

Case vi. *Summary.* A fifteen year-old boy, stunted in growth, blind in one eye with barrel vision in the other and signs of pituitary dysfunction is found to have a large cystic duct tumor. Tumor removed and patient survives the operation twenty months.

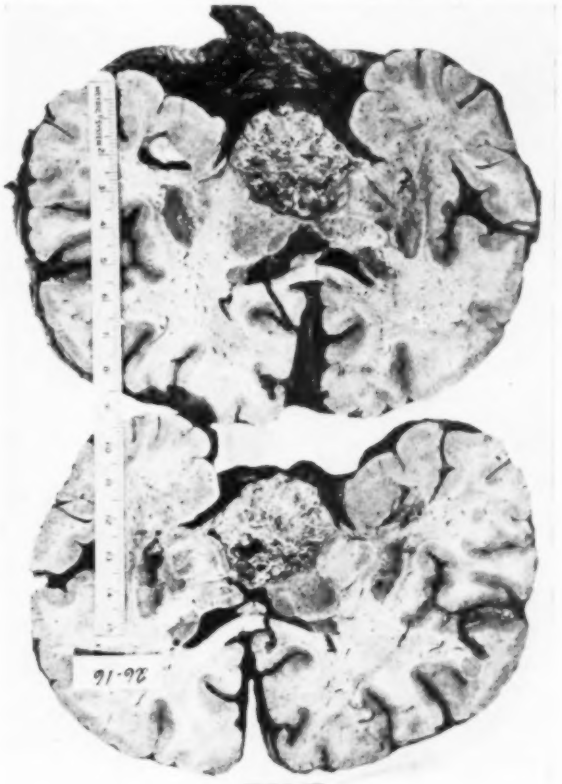


Fig. 29. Case vii. Cross section of brain showing an adamantinoma of pharyngeal duct, retrochiasmal.

Case vi. L. F. male, aet. fifteen years, File No. 14909 was admitted to the Neurosurgical Service of the University Hospital Nov. 9, 1928.

History. In the spring of the year 1928 his vision began to fail. At the time of admission the vision of the left eye was practically lost, and in the right eye vision was beginning to be affected. He had had occasional frontal and occipital headaches, at times severe, but there were no other subjective complaints.

Examination. Residual paralysis of the lower extremities (infantile paralysis).

Pituitary Stigmata. Dwarfism. Delayed development of external sexual characteristics. Basal metabolism minus 15. (Fig. 21.)

discs. Fields O. S. blind. O. D. concentric contraction. Barrel vision. (Fig. 22.)

Roentgenogram. Marked enlargement of the

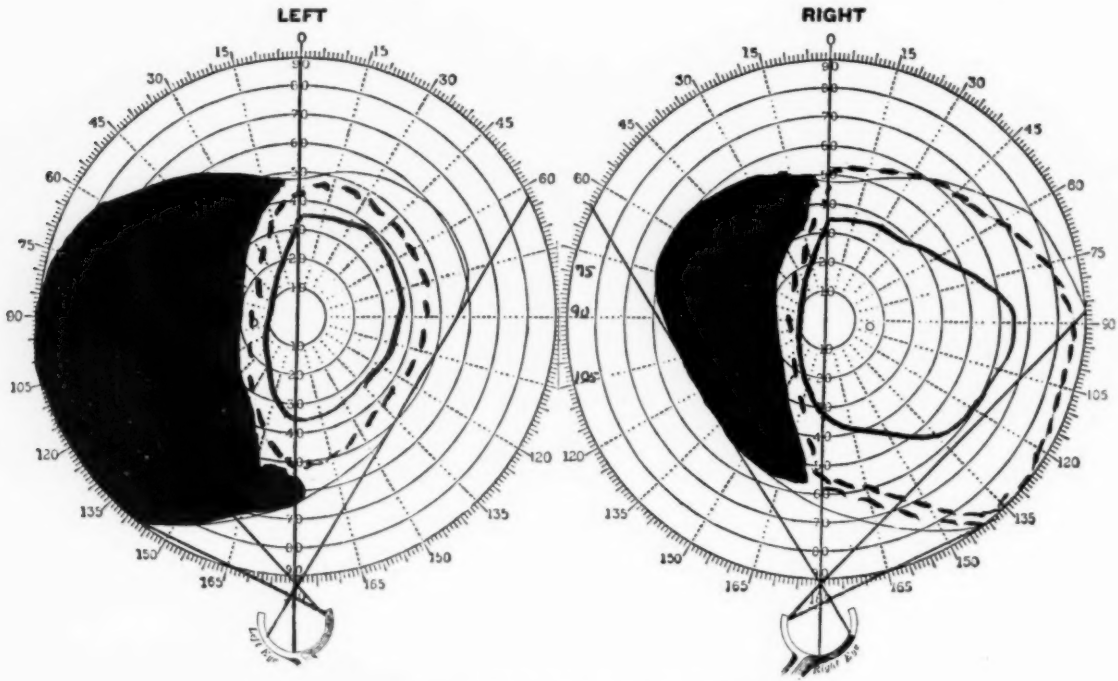


FIG. 30. Case VIII. Left homonymous hemianopsia.

FIG. 31. Case VIII. A.P. view showing shadow of cyst filled with air.

FIG. 32. Case VIII. Suprasellar teratoma.

pituitary fossa, vertical 19 mm. anteroposterior 23 mm. Pansinusitis, except sphenoid sinus. (Fig. 23.)

Operation. Transfrontal craniotomy, right, Nov. 9, 1928. Because of the manifest enlargement of the pituitary fossa, the arrest of growth and sexual development of the patient and his age, a preoperative diagnosis of pharyngeal duct tumor was made.

A flap was reflected on the right side because the patient was blind in the left eye and there was hope only of restoring vision in the right eye. The dura was moderately tense, but an

attempt to tap the anterior horn of the ventricle failed. A horizontal incision was made in the dura and the frontal lobe elevated following the line of the greater wing of the sphenoid bone. Soon the lesion of large dimensions was seen presenting in front of the chiasm. (Fig. 24.)

Fig. 33. Case VIII. Patient, left, taken beside boy of his own age, showing sexual precocity.

The lesion proved to be chiefly cystic and with an aspirating syringe 17 c.c. of a yellowish red crystal laden fluid was evacuated. The capsule then collapsed, was incised and a large amount of solid tissue was removed with a curet. With a pair of long handled curved scissors, a considerable portion of the capsule on the right side was removed. The lesion was so extensive that that portion adjacent to the left optic nerve could not be readily exposed. When the operation was concluded the right optic nerve was entirely free and a cavity the size of an English walnut remained. Hemostasis was effected with tampons of adrenalin, the cavity swabbed with iodine and the wound closed without drainage.

Fig. 34. Case VIII. Note area of calcification over pituitary fossa.

Postoperative Note. The convalescence was uneventful. A week after the operation the patient could count fingers with the right eye and on the ninth day his vision in that eye was 6/9 (before the operation only light perception). The fields had widened considerably. Nov. 28, 1928, nineteen days after operation, the patient was discharged.

Subsequent Notes. In the course of the next two years the patient was seen from time to time. Signs of pressure recurred, the patient became somnolent, gained 10 pounds in weight, had attacks of headache and vomiting, the metabolic rate was minus 46. He died July 8, 1930, twenty months after the transfrontal craniotomy.

Judging from the sellar deformation one might presume an intrasellar adenoma. There was the characteristic ballooning of the sella, the sphenoid sinus was obliterated, the dorsum sella intact. To account for this the tumor must have taken its origin from the lower of the two epithelial rests in

the craniopharyngeal duct. There was no calcification. On the other hand, the patient was an adolescent only fifteen years old, his all respects, save in the age of the patient, the clinical characteristics were not unlike those of an intrasellar adenoma.

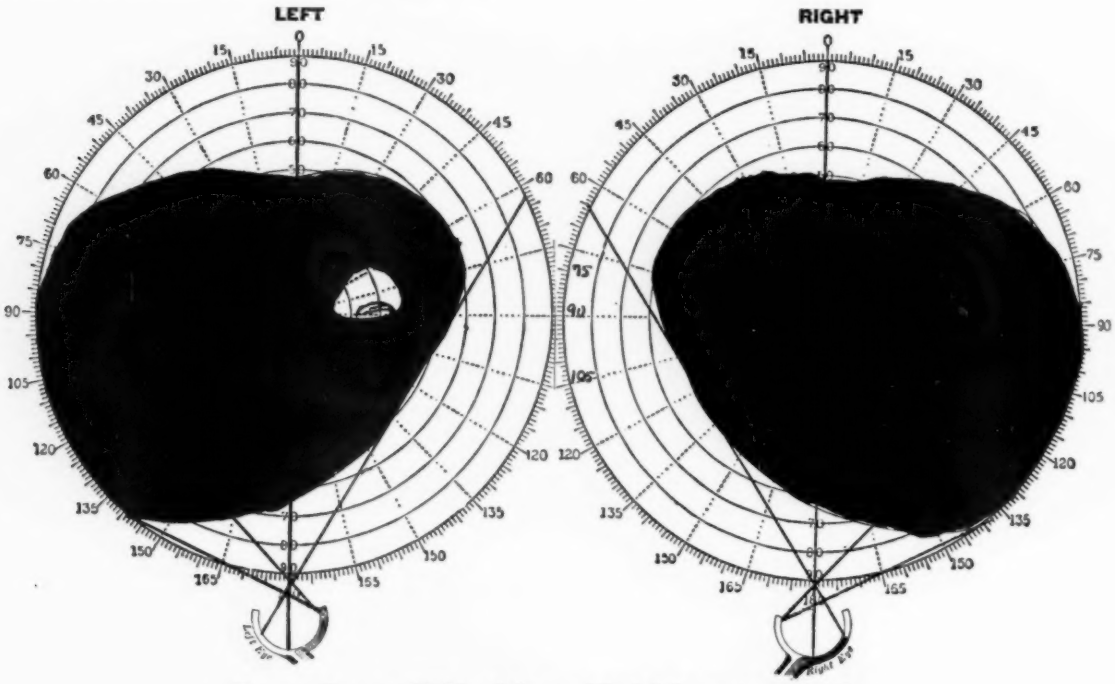


Fig. 35. Case ix. Fields: right eye blind, left eye central vision.

Fig. 36. Case ix. Advanced atrophy of dorsum sellae, erosion of sella floor with encroachment on sphenoid sinus.

growth was stunted, there was delayed development of the external sex characteristics, there was a primary optic atrophy and contraction of the visual field. Thus in

In contrast to this case, consider the following:

Case vii. *Summary.* Middle aged woman develops signs of pituitary dysfunction at first without change in fields or sella but later an homonymous hemianopsia. An exploratory(trans frontal) craniotomy but no tumor visible in prechiasmal or pituitary space. Some improvement followed by relapse with frontal lobe symptoms superimposed. A year after she first came under observation the patient succumbs (January 15, 1926). Pathological diagnosis: adamantinoma (retrochiasmal) of pharyngeal duct.

Case vii. Mrs. C. W. K. aet. fifty years, File No. 4609 N.S. was referred to the Neurosurgical Service of the University Hospital by Dr. Burton Chance, Dec. 4, 1924.

History. The family history and history of previous illness were inconsequential. She was married and had had one miscarriage. April 1924, she noticed dimness of vision; it seemed as though a cloud were before the eyes. Since

May the sight has failed considerably. She has noticed no narrowing of her fields. She has a ravenous appetite, has gained from 173 to 243 pounds, is always tired and ready to sleep. She has to void frequently, sometimes every half hour. Since July she has been able to read only the headlines of the newspaper. In August she had an hallucination; thought she was surrounded by big black dogs. She is restless and has occasional bitemporal headaches.

Examination. On admission the following findings were noted.

Endocrine Disturbances. Accession in weight (70 pounds), fatigues easily, polyuria, basal metabolism minus 21. (Fig. 25.)

Ocular Disturbances. Vision O. D. 6/22, O. S. 6/15. Diplopia, lack of convergence, pupils sluggish, fundi greyish-yellow color.

Roentgenogram. Sella turcica, depth 7.5 mm. A.P. 10.5 mm. In all other respects negative. (Fig. 26.)

Barany reactions suggested a cerebral rather than a cerebellar lesion.

In the absence of any signs of sellar deformation or any pressure phenomena the patient was discharged December 11, 1924 to continue under Dr. Chance's observation.

Readmission. January 14, 1925. Since the last admission, December 4, 1924 there has been definite deterioration of vision and there developed for the first time marked field distortion. The nervousness, polyuria, headache and diplopia have persisted.

Further examination revealed a basal metabolism of minus 25, intracranial pressure 234

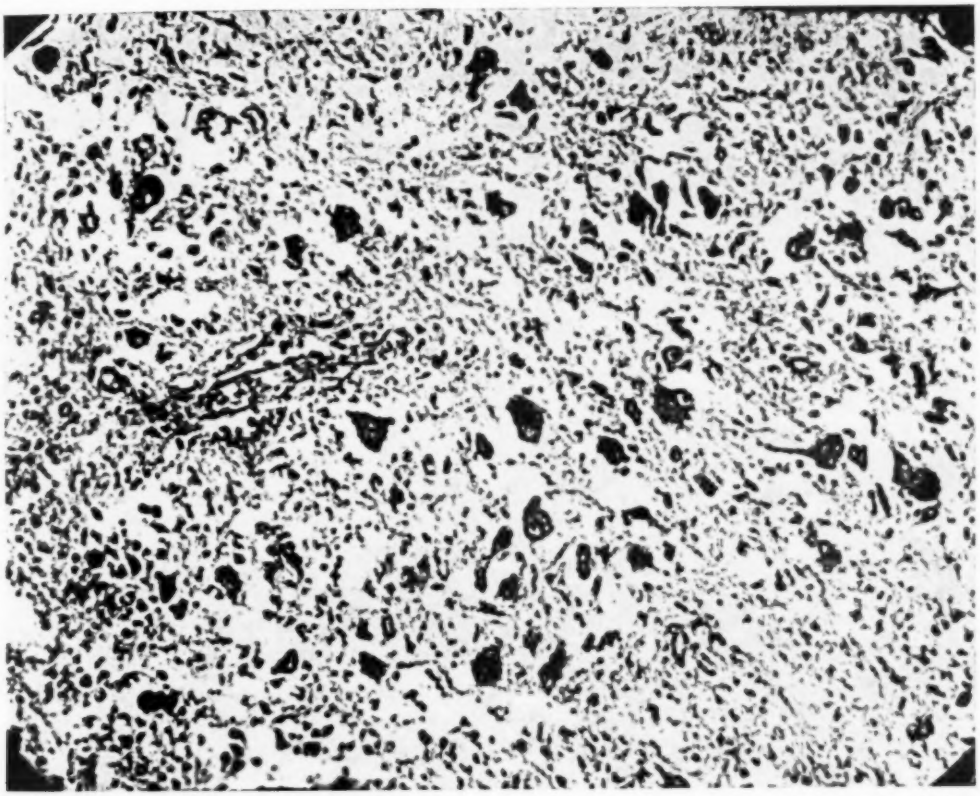


Fig. 37. Case ix. Low power photomicrograph of tumor showing numerous ganglion cells scattered throughout it.

Fig. 38. Case xi. Photograph of patient.

mm. and a left homonymous hemianopsia. (Fig. 27.) Her vision now is O.D. 6/30 O. S. 6/22. The measurements of the sella turcica have not changed (7.5 × 10.5).

With these manifest signs of pituitary dysfunction the oncoming field distortion, the deteriorating vision, a cranial exploration seemed indicated. Provisional diagnosis "extrasellar tumor."

Operation. Transfrontal craniotomy, right. January 19, 1925. Local anesthesia. Tumor not found. Flap reflected. Dura especially adherent, particularly in the region above the orbit. There appeared to be no increase in intracranial pressure. There was an excessive amount of cerebrospinal fluid which, upon evacuation, facilitated elevation of the frontal lobe. A liberal exposure was obtained of the chiasm and the optic nerves, but there was not a sign of tumor in the sella or out. The wound was closed. In the middle of the operation the blood pressure rose suddenly from 125 to 175, soon dropping back again to the original level. It seemed as though an additional amount of pituitrin might have been liberated during the manipulations.

Except for one convulsion, the patient's convalescence was uneventful, but before her discharge it was thought wise because of the negative findings in the pituitary region, to do a subtemporal decompression. This was performed February 11, 1925 (F. C. G.) and the patient was discharged February 25, 1925.

Included in the period February 25, 1925 to the date of her death, January 15, 1926, the following notations were made:

March 10, 1925. The patient is very much depressed, seems to have hallucinations, speaks of imaginary sounds, "the kids" "turtles."

June 8, 1925. The left homonymous hemianopsia has disappeared and vision is about the same. O. D. 2/60, O.S. 6/60. The discs are of fairly good color though somewhat blurred on the edges. Retinal veins engorged.

June 19, 1925. Patient depressed, childish, dirty in personal habits, has delusions, has enormous appetite, drinks 4 quarts of milk daily. Much headache.

January 10, 1926. She was readmitted to the hospital in a semistuporous state and died five days later, January 15, 1926. For the first time the sella had increased in size. Measurements A. P. 10.5 mm. V. 10 mm. (Formerly A.P. 10.5 mm. V. 7.5 mm.)

At this time the fields could not be taken; the patient was practically blind, but there was no elevation of the discs.

Pathological Diagnosis. Adamantinoma. (Figs. 28 and 29.)

Manifestly in this case we were not dealing with an intrasellar adenoma. Before the operation and when first seen we had in mind a suprasellar meningioma, as the patient was in her fiftieth year, and the tumors of embryonic origin usually, though not always, occur in adolescents.

Calcification is said to be characteristic of the craniopharyngioma, but there was no calcification in either of the 2 cases just cited and others might be cited from our series without calcareous deposits. Furthermore, it must be remembered, that in suprasellar meningiomata as well as in intrasellar adenomata calcification is sometimes observed. So that given a tumor without calcification and without any alterations in structure of the sella turcica, the dorsum sellae or clinoid processes, it seemed impossible before operation to make an exact diagnosis.

In this case it so happened that the field distortion was an homonymous hemianopsia. This was really of no diagnostic importance as we have observed that the fields in the craniopharyngeal adamantinomata are extremely variable; they include a bitemporal hemianopsia, homonymous and binasal hemianopsia, concentric contraction or no obscuration of the fields at all. It is interesting to note that in every case of bitemporal hemianopsia the tumor presented prechiasmal. In the binasal or homonymous hemianopsias the tumor was retrochiasmal.

The 2 cases of adamantinomata we have cited for illustration differed in this important respect, the first took its origin from the lower of the two epithelial rests and was largely prechiasmal and the latter from the upper of the two rests and was entirely retrochiasmal. A tumor of this origin may be, as it was in Case VII, wholly inaccessible. Not a vestige of the tumor was seen at the operation.

VI. TERATOMA

Among the more unusual tumors that may take their origin from the region of the pituitary are the teratomata. In our entire series we have but 2 verified cases, one of which will be cited. Frankl Hochwurt[1] found only two examples in 97 pituitary tumors. Hosoi[2] collected 41 cases of teratomata of the brain, 17 of which were true teratomata and 23 teratoid tumors. Chiefly among the latter were 7 of pituitary origin and 2 of the pituitary region. The principal interest in these tumors has to do with their precise origin and composition. The ectodermal and mesodermal elements prevail. The endodermal tissue if present is of an embryonic type resembling the chorda, there are cystically dilated spaces lined with goblet cells and respiratory epithelium in close relation to cartilage. As one might expect these tumors arise near the midline where there is greater likelihood of misplacement of embryonal tissue.

Case VIII. *Summary.* A boy of nine years had signs of intracranial pressure for seven years. When first seen there was evidence only of a right sided temporoparietal tumor. In the course of the next six years evidence of a suprasellar lesion gradually developed. The tumor proved to be a teratoma.

Case VIII. E. K. male aet. nine years, File No. 65844 was admitted to the Neurosurgical Service of the University Hospital June 1, 1922.

History. From his second year he was subject to severe headaches and spells of vomiting at two week intervals. At that time he was above the average intelligence, but took little part in games. Six months ago it was noticed his mouth was drawn to the right. His gait became unsteady and his memory began to fail. His head was increasing rapidly in size and a month ago there was a bulging on the right side of the head. Then followed general convulsions, two or three a day.

Examination. Somewhat underdeveloped physically and now of inferior mental grade. The left arm and leg are manifestly weak and there is a partial paralysis of the face of central origin. The tendon reflexes are exaggerated on the left side with a positive Babinski on the left. There seems to be impairment of pain sense on the left side of the body and face; also left sided adiadokokinesis and dysmetria. There is a lobulated swelling in the right temporal region. The surface is hard except at one point, the size of the tip of one's finger, which can be depressed upon pressure.

Ocular Disturbances. Discs O. D. plus 5, O. S. plus 4. Horizontal nystagmus on lateral rotation and slight rotatory mystagmus on upward rotations. (Fig. 30.)

Roentgenogram. Convolutional atrophy. Increase in size of sella.

Cerebrospinal Fluid. Pressure 260 mm. Globulin negative. Cells 5.

Operation. Exploratory craniotomy. Upon introduction of a canula, when the flap was reflected, 170 c.c. of a yellowish oily fluid were evacuated. A portion of the cortex over the cyst was removed for examination and the wound closed. (Fig. 31.)

Postoperative Note. Before discharge the hemiparesis had disappeared and he had no more convulsions. From that time until his death, December 17, 1927 he had been readmitted to the hospital five times. On three occasions the cyst was evacuated. A fourth attempt failed. The cyst cavity had evidently become filled with the tumor mass. On the last admission an exploratory craniotomy, transfrontal, was performed. The tumor was exposed but not removed. At the autopsy a large calcified tumor was revealed which proved on examination to be a teratoma. (Fig. 32.)

During the six years he was under observation the clinical picture changed in many respects. He developed (1), sexual characteristics suggesting pineal invasion (Fig. 33), (2) a left homonymous hemianopsia and (3) an *x*-ray evidence of suprasellar calcification. (Fig. 34.)

Discussion. In this case the prevailing evidence of a right hemispheric lesion was misleading. It was not until later that we discovered by *x*-ray evidence that the eyst floor was in juxtaposition to the sella turcica. When still later an homonymous hemianopsia developed and the *x*-ray revealed calcification our minds turned to a

[1] *Wien. med. Wchnschr.*, 59: 2326, 1909.
[2] *Arch. Path.* 9: 1207, 1930.

tumor of embryonic origin, whether a duct tumor or a teratoma was problematical.

Because of the age of the patient, the first symptom was observed in his second year, one might presume a tumor of congenital origin, although neither teratomata nor duct tumors develop solely in childhood. There may be changes in the sella, but these are not such as are found in the primary intrasellar adenoma.

VII. GANGLIONEUROMA

Of the 70 cases of ganglioneuroma reported in literature 18 occurred in the central nervous system, 4 were from the tuber cinereum. It is not at all unlikely that these tumors arise from inactive cells of the original basal plates, which do not have a definite function. According to Courville[1] through some form of stimulation these cells assume a neoplastic nature and progress through the stages which lead to the adult form of cell.

Case IX. *Summary.* An adolescent for four years has signs of intracranial pressure, which later become acute. Apart from pressure phenomena, a block of the third ventricle, atrophy of the dorsum sella and enlargement of the sella turcica, there are no localizing phenomena.

CASE IX. E. G. male, aet. sixteen years, File No. 17449, was admitted to the Neurosurgical Service of the University Hospital 11.18.29, complaining chiefly of headache and pain behind the ears.

History. The patient has had headache and pain behind the ears for four years. These attacks occurred at intervals of a few days usually morning and night and at times were associated with nausea and vomiting. One year ago he began to have difficulty in reading; the print seemed blurred and glasses failed to improve vision. There was little variation in his condition until four weeks ago when the headaches increased in frequency and severity and were almost constant. He cannot read now and for the past two weeks has had transitory blind spells lasting a minute or two.

Examination. A well-nourished boy, his gait somewhat unsteady with tendency to fall to the right. Intelligent and cooperative, expression apathetic.

With the left hand he past points in the vertical plane 3 inches to the right; in the horizontal plane with the left hand he drops 2 inches.

There are no involuntary movements, no paralyses and no objective disturbances.

Ocular Disturbances. O. S. and O. D. plus 5 D. Vision is lost in the right eye and only slight perception in the central field of the left eye. There is no reaction on either side to light consensual, direct, accommodation or convergence. There is weakness of the left external rectus. No nystagmus. (Fig. 35.)

Roentgenogram. Atrophy of the dorsum aellae, advanced, erosion of the sellar floor, which encroaches on the sphenoid sinus. The pituitary fossa is enlarged. (Fig. 36.)

Cerebrospinal Fluid. Pressure 640 mm. Cells 6, protein 3 units. Wassermann reaction negative.

Operation (F. C. G.) December 11, 1929. A ventriculogram showed enlarged lateral ventricles and obliteration of the third ventricle. A large right transfrontal flap was reflected and when the right ventricle was tapped the right hemisphere collapsed. Upon elevation of the frontal lobe as in the approach to a pituitary lesion, the tumor was exposed. The capsule was incised and the solid contents removed by suction. It did not seem feasible to remove the tumor. Pressure had been relieved upon the right optic nerve, but the chiasm was not seen. After decompressing in the temporal region the wound was closed.

Six hours after operation the left ventricle was tapped and the following morning the right ventricle. At this time hypothermia set in and the patient died in the course of the afternoon.

Pathological Diagnosis. Ganglioneuroma. (Fig. 37.)

Discussion. The striking features in this case were the duration of the illness, four years, the age of the patient, the absence of calcification, of endocrine symptoms of field distortion and obliteration of the third ventricle. As ganglioneuromata arise most commonly in the tuber cinereum, in the floor of the third ventricle, one would expect as an early symptom pressure phenomena, headache and papilledema.

[1] *Arch. Neurol. & Psychiat.*, 24: 488, 1930.

This relationship accounts for the sudden deaths from pressure that have been reported in a number of cases. Differentiation from a true pituitary lesion in this case might be based upon the absence of endocrine symptoms and the characteristic sellar deformation; from tumors of the craniopharyngeal duct by the absence of calcification and hemianopsia. Hemianopsia is not uncommon in craniopharyngeal duct tumors but hemianopsia has not been recorded in the ganglioneuromata. Before operation it will always be difficult to make positive assertions. But evidence of a tumor in a youth or young adult, with evidence of third ventricle obstruction, with atrophy of the dorsum sellae, without calcification and without hemianopsia should lead one to think of a congenital tumor, possibly ganglioneuroma, in this neighborhood.

VIII. SUPRASELLAR ARACHNITIS—PSEUDOTUMOR

In a previous communication I have recorded 22 cases of pseudotumor.[1] Half of these were in the posterior fossa, the other half were pretentorial. The underlying pathology is alleged to be a localized arachnitis, but the pathological diagnosis has been confirmed but once. As a matter of fact, we know little if anything of the etiology or pathology. The most that one can say is that occasionally localized collections of fluid may give rise to symptoms which simulate tumors. Hence the term, pseudotumor, as Nonne first designated this condition.

Case x. *Summary.* With symptoms suggesting a lesion in the pituitary region, six years after the evacuation of cerebrospinal fluid at a transfrontal exploration, vision is conserved and the patient physically well and actively engaged in business.

Case x. O. T. G. aet. twenty-one years, male. File No. 2759 N.S. was admitted to the Neurosurgical Service of the University Hospital January 14, 1924.

History. The patient had had measles as a child. At the age of seven he noticed he could not see as well with the right eye. Between his seventh and his fourteenth year he had convulsions. At fourteen he developed diplopia. For the past three years he has had visual hallucinations (sees zig-zag lines like streaks of lightning).

Examination. The patient weighed 210 pounds, the fingers were tapering, there were deposits of fat suggesting pituitary dysfunction. His basal metabolism was minus 22. He had a right homonymous hemianopsia. In other respects his examination was negative.

Operation. Transfrontal craniotomy January 23, 1924. Apart from an excessive collection of fluid the exploration was negative.

Postoperative Note. Six years after the operation he wrote that he had not felt so well for years. He had gained only 3 pounds, his vision had not deteriorated (O. D. 6/15, O. S. 6/9). The hemianopsia had persisted.

Discussion. This case is cited merely to illustrate the possibility of mistaking a pseudotumor for a solid tumor in the pituitary region. There was no reason to suspect a true pituitary tumor in this instance as the sella was not enlarged. But there were suggestive pituitary stigmata and field distortions. We are so accustomed in our operations in the suprasellar region to find a considerable quantity of cerebrospinal fluid that we were not surprised to find an abundance of fluid in this particular case. It was not until six years had elapsed and there was no evidence of recurrence or progression that we classified this case as "pseudotumor."

In this discussion of the differential diagnosis of tumors intrasellar and parasellar, I have not referred to glioma of the chiasm or to aneurysms. The former is relatively infrequent, the diagnosis is usually conjectural unless there is a definite excavation under the anterior clinoid processes. The patients are mostly adolescents and there is of course a bitemporal restriction of the fields.

One is unlikely to confuse an aneurysm of the internal carotid artery or the circle of Willis with a sellar or suprasellar tumor.

[1] *Arch. Neurol. & Psychiat.*, Dec. 1930.

Usually not suspected until the time of rupture, violent headache, bloody cerebrospinal fluid with loss of consciousness for the first time reveals the true nature of the lesion. Paralysis of the third, fourth and sixth cranial nerves may eventuate with anesthesia in the trigeminal distribution.

IX. SUPRASELLAR FIBROBLASTOMATA

Finally, there remain for consideration the suprasellar fibroblastomata or meningiomata which originate at the tubercle of the sella turcica.

Reviewing the cases which have passed through our clinic, the following seem to be outstanding features; the patients are adults, mostly between forty and fifty; the duration of the symptoms is expressed in years not months, headache is common; the roentgenogram may be normal or at most there is atrophy of the clinoid processes, never ballooning of the sella turcica; there is asymmetry of the visual picture, the vision of one eye almost always affected before the other; field distortions may or may not be present and if present they may be of various types, hemianopsias, central or temporal scotomata; primary optic atrophy, not papilledema, is invariable; if the tumor be large and involve adjacent structures there may be a hemiparesis loss of sense of smell, dreamy states.

The following case is more or less illustrative of the suprasellar fibroblastoma.

Case XI. *Summary.* A suprasellar fibroblastoma is removed from a middle-aged patient who began to complain of blurred vision six years ago. Apart from primary optic atrophy there were no suggestive symptoms. The *x*-ray was normal.

Case XI. E. J. B. female, aet. fifty-one years, File No. 8215 N. S. was admitted to the Neurosurgical Service of the University Hospital April 28, 1926. (Fig. 38.)

History. For six years there had been blurring of vision in her right eye and three years ago there appeared a mist before the left eye. Two years ago she lost vision in the right eye. About this time she was drowsy most of the time and would fall asleep frequently. She had occasional headaches mostly bitemporal and a form of visual hallucinations, which she described as a picture of autumn leaves.

Examination. With the exception of her visual disturbance the examination was entirely negative, except for signs of primary optic atrophy. The roentgenogram was normal in that the sella was not enlarged. At most there might have been a slight atrophy of the posterior clinoid processes.

Operation. Through a left transfrontal exposure an encapsulated tumor the size of a plum was revealed. The right optic nerve was displaced to the outer side of the growth. A subcapsular removal of the tumor was effected and the wound was closed.

Postoperative Note. The patient made an uneventful convalescence and four years after the operation was in good health. Unfortunately the optic atrophy was so far advanced that vision was not restored.

Discussion. The duration of the lesion, the absence of sellar deformation and the age of the patient clearly differentiated this lesion from one of pituitary origin, if intrasellar. One might be confused were the lesion a suprasellar adenoma, but with the latter the development is more rapid, the average age younger, and there is more likely to be evidence of pituitary disturbance of one variety or another.

There is little in common between the suprasellar fibroblastoma and the craniopharyngeal tumor, except in that both there may be no striking alterations in the conformation of the sella turcica. In the stalk tumors the patients are usually younger, calcification more common, papilloedema not infrequent and if endocrine disturbances are present, as they often are, they are drowsiness, femininity, adiposity, infantilism and sex depression.

A MODIFICATION OF THE DEVINE OPERATION OF PYLORIC EXCLUSION FOR DUODENAL ULCER*

FREDERIC W. BANCROFT, M.D., F.A.C.S.

NEW YORK CITY

WHEN a duodenal ulcer is complicated by gastric retention due to an organic stenosis it is the consensus of opinion that gastroenterostomy is the operation of choice, but where there is a postpyloric lesion without retention gastroenterostomy has not given as satisfactory results as one might wish. This is indicated by the numerous operative procedures that have been devised in place of gastroenterostomy, such as the Horsley, Judd and Finney pyloroplasty, and finally the subtotal gastrectomy. This last procedure, in the hands of the general surgeon, presents a mortality which precludes its adoption as the operation of choice. Feeling, therefore, that there is a middle path in the surgical treatment of duodenal ulcer that is more satisfactory than gastroenterostomy and less radical than subtotal gastrectomy, we present a modification of the Devine operation of antral trans-section and exclusion with a Polya gastrojejunostomy. No claim for originality of this procedure is made in this presentation.

While the operation of gastroenterostomy is relatively simple in textbook description it is, from a technical point of view, not so easy to perform.

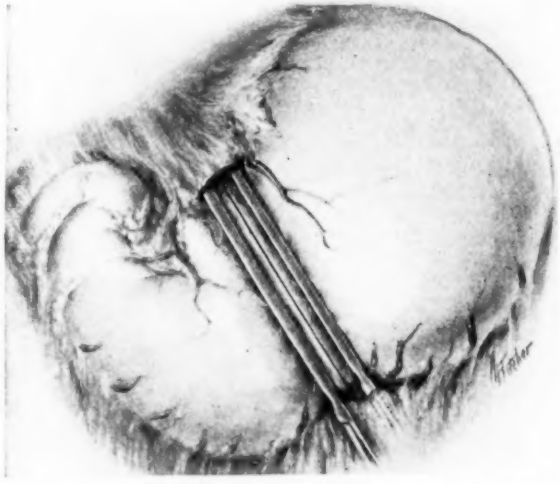


FIG. 1. Ligation of vessels in gastrohepatic and gastrocolic omentums, insertion of proximal crushing clamp through transverse mesocolon and distal clamp inserted across stomach proximal to reentrant angle.

FIG. 2. Antrum of stomach after removal of distal clamp. Insertion of temporary rubber band tourniquet to diminish bleeding. Dotted lines: Schematic relationship of vessels. Insert shows method of controlling tourniquet.

After the mesocolon has been perforated and the posterior surface of the stomach drawn into the operative wound and the proximal loop isolated, it is difficult to feel sure that the line of the stoma or the direction of the jejunum is in position to allow satisfactory function after replacement of the viscera within the abdominal cavity. Moreover, even in the hands of good surgeons, the mortality is higher than it is generally believed to be.

Devine[1] described an operation wherein he cut across the antrum of the stomach

[1] Devine, H. B. Gastric exclusion. *Surg. Gynec. Obst.*, 47: 239, 1928.

* Read before the Southern Surgical Association, December 8, 1931.

at about the reentrant angle, inverted the distal portion and drew the proximal portion through the mesocolon and permentally the antral pouch, while contracted, contains a greenish detritus which would seem to be obnoxious.

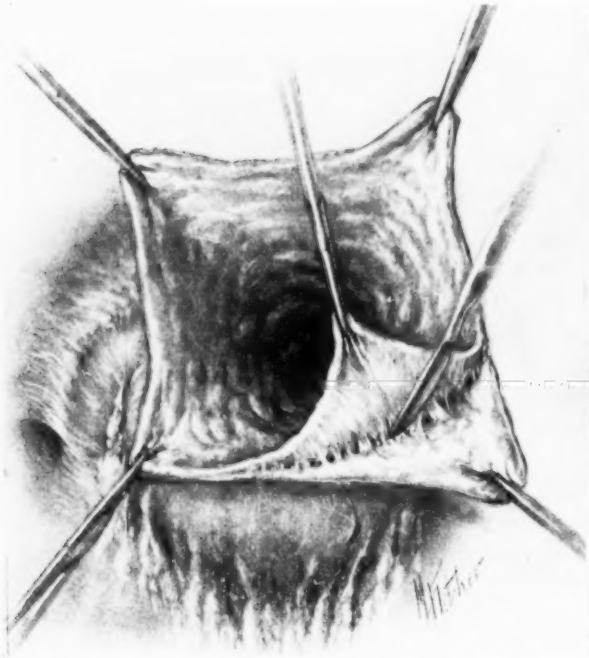


Fig. 3. Beginning dissection of mucosa from muscularis of antrum.

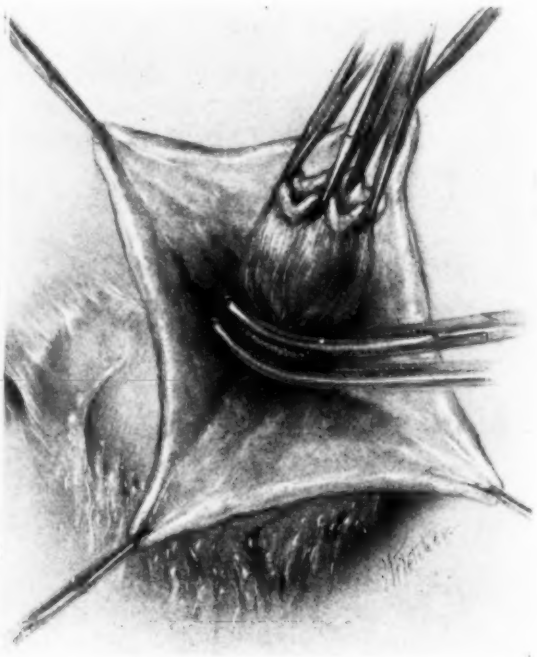


Fig. 4. Completion of dissection of mucosa. Clamps applied before insertion of inverting mucosal suture.

formed a Polya anastomosis with the proximal loop of jejunum. Theoretically this operation has the following advantages over subtotal gastrectomy: (1) It is unnecessary to dissect the antrum and pylorus free from the gastrohepatic and gastrocolic omentums. (2) It obviates the necessity of dissecting ulcers located on the posterior surfaces of the duodenum from the head of the pancreas. (3) Where the ulcer is situated near the papilla of Vater closure of the duodenum stump has presented marked technical difficulties; these difficulties are obviated by this operation. It has the following theoretical disadvantages: (1) There is left a gastric mucous membrane in the distal portion of the stomach which may continue to bathe the ulcer with its secretion and thereby delay healing. (2) It is generally considered an inadvisable surgical procedure to leave a blind pouch anywhere in the gastrointestinal course. In dogs where this operation has been done experi-

As a means of correcting the aforementioned disadvantages of the Devine operation, Dr. Lewis Gregory Cole suggested that this operation could be improved by coning out the mucous membrane of the antrum as far as the pylorus and then inverting the mucosa and muscular coats. The details of this procedure are to be described in the latter part of this article. At the beginning of my connection with the Fifth Avenue Hospital, Dr. Cole, chief of the radiological department, Dr. Tenney, chief of the medical department, and myself, as chief of the surgical department, came to a working agreement that no case of duodenal ulcer should be referred for operation unless two out of the three decided that operation was advisable. It was our opinion that no case should become surgical unless it had had a prolonged and satisfactory course of medical treatment or unless there was radiological evidence that perforation might ensue unless operative pro-

cedure was carried out. As a result of this agreement the surgical department has not had a great number of cases referred for operation: In addition, the cases that have been referred are obviously medical failures and therefore should not be grouped on equal terms in analyzing follow-up results with early submucous ulcers, duodenitis and similar conditions which are included in any analysis of medical treatment of ulcer.

I propose to present 14 consecutive cases of duodenal ulcer subjected to the modified Devine operation of pyloric exclusion. I realize that this series is small and that a follow-up of three and one-half years, which have elapsed in the oldest cases, is not sufficient for a complete end-result analysis; but this is a carefully selected series of cases that have defied medical treatment and wherein it has been the consensus of opinion of the attending physician, surgeon and radiologist that operative procedure is indicated.

In an earlier discussion with Dr. Cole about the end results of the patients subjected to operation he made the statement that no surgeon could give a proper evaluation of his own operation any more than a father could properly evaluate his own son. I then made the suggestion that I would send for all cases operated upon and leave the evaluation of the follow-up to Dr. Cole and would stand by his conclusions. As Dr. Cole has been opposed in general to operative procedure in duodenal ulcers it would seem that the study of end results is fairly accurate.

DESCRIPTION OF OPERATION

As the illustrations show clearly the steps of the operative procedure only the important points will be mentioned. We have found that the incision described by Tate Mason gives the best exposure of the stomach and appendix. After opening the peritoneum and inspecting the pathology of the stomach and duodenum the vessels of the lesser curvature are ligated just proximal to the reentrant angle over an area sufficient to insert two gastric clamps. A similar procedure is carried out on the greater curvature opposite

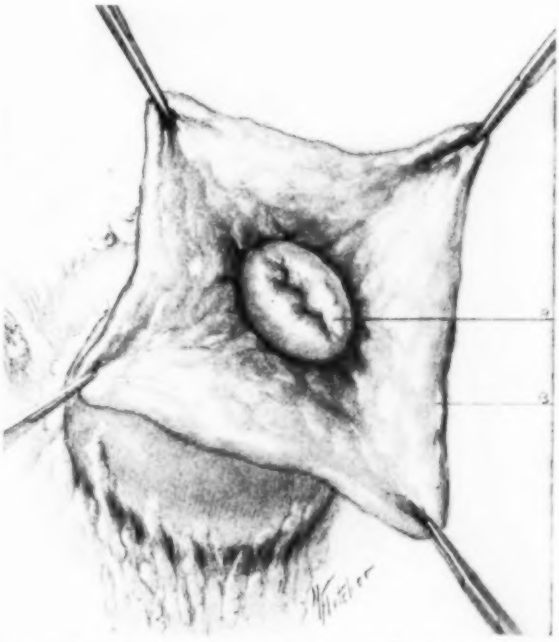


Fig. 5. Completion of inverting mucosal stitch. Antrum is then closed with two to three purse-string sutures, final one being an inverting peritoneal suture.

the site chosen on the lesser curvature. Next the transverse colon is drawn up into the wound and its mesocolon is perforated in the avascular area. A Peyer crushing clamp is inserted through this perforation so that the blades pass one on each surface of the stomach. A second non-crushing clamp is applied distal to the Peyer clamp but is inserted through the perforation of the gastrocolic omentum and not through mesocolon. (See Fig. 1.)

The stomach is cut across close to the crushing clamp with either cautery or carbolized knife. The Peyer clamp enclosing the proximal portion of the stomach is wrapped in a sterile string pad, to protect the wound from contamination. Allis clamps are applied to the cut end of the distal portion, the distal gastric clamp is removed and the lumen of the antrum exposed. (Fig. 2.) At this stage a finger may be passed through the pylorus and the lumen of the duodenum palpated

from within for ulcer. I have found that if a rubber band is applied as a temporary tourniquet about the pylorus, as shown in Figure 3, it diminishes the bleeding while the mucosa is being excised.

The dissection of the mucosal layer is carried out as shown in Figures 4 and 5. When the prepyloric area is approached a Kocher clamp is applied and the dissected mucosa excised. The pyloric mucosa is closed with an inverting suture. The temporary tourniquet is then removed, bleeding points are clamped and ligated, and the antrum closed with two or three purse-string sutures and a final inverting peritoneal suture.

Figures 6 and 7 show the latter steps of the anastomosis. The jejunum is isolated close to where it presents from the fossa of Treitz and is anastomosed side to end with the stomach so that the proximal portion of the jejunum, about 4 to 7 cm. from the fossa of Treitz, is attached to the lesser curvature. The anastomosis is made *without* clamps after the excision of the portion of the stomach within the bite of the Peyer crushing clamp. Care is taken to ligate all bleeding points. Three layers of sutures

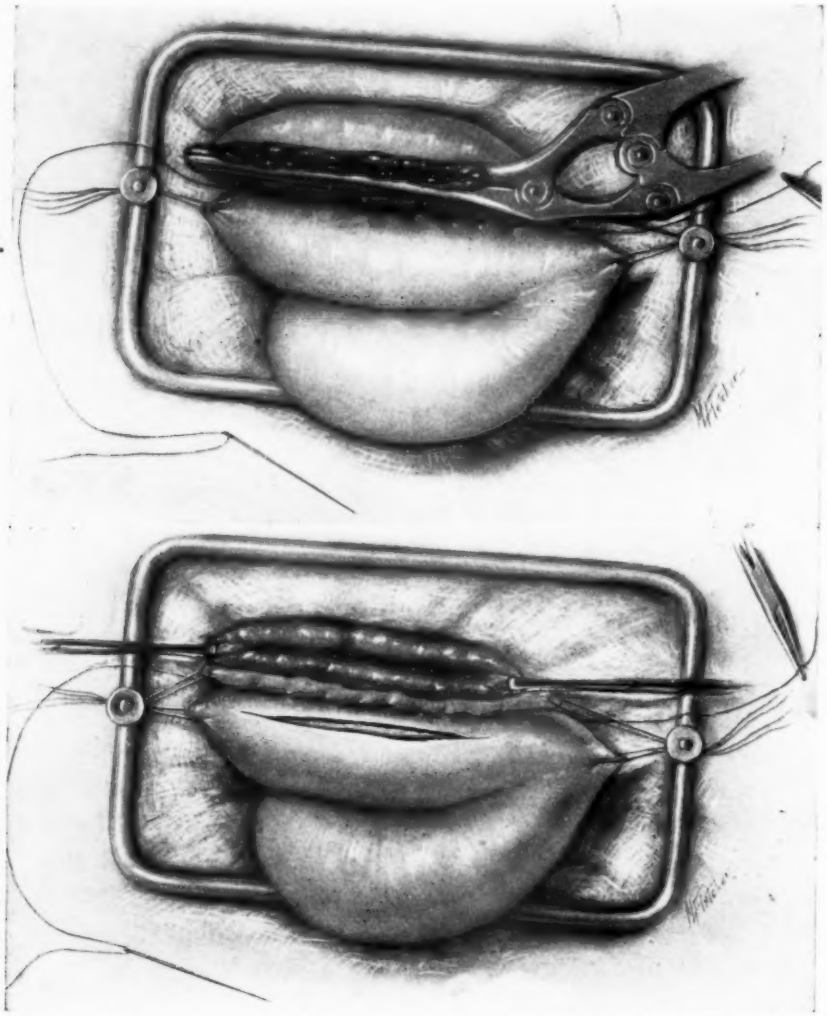


FIG. 6.

FIG. 7.

FIG. 6. Proximal portion of stomach drawn through transverse mesocolon and beginning anastomosis with proximal portion of jejunum. Lesser curvature is united to proximal portion of jejunum shortly after its emergence from fossa of Treitz.

FIG. 7. Continuation of anastomosis after portion of stomach which has been held by bite of crushing clamp has been excised.

are applied anteriorly and posteriorly, particular care being used to unite the mucous membrane. Figures 8 and 9 show

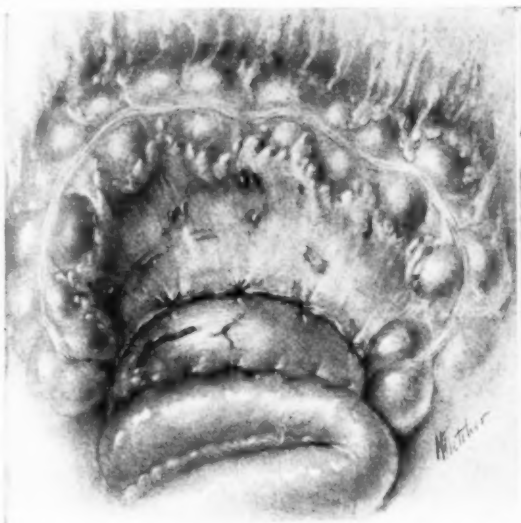


Fig. 8. Appearance of anastomosis after its completion, showing mesocolon united to stomach 1 to 2 cm. proximal to anastomosis.

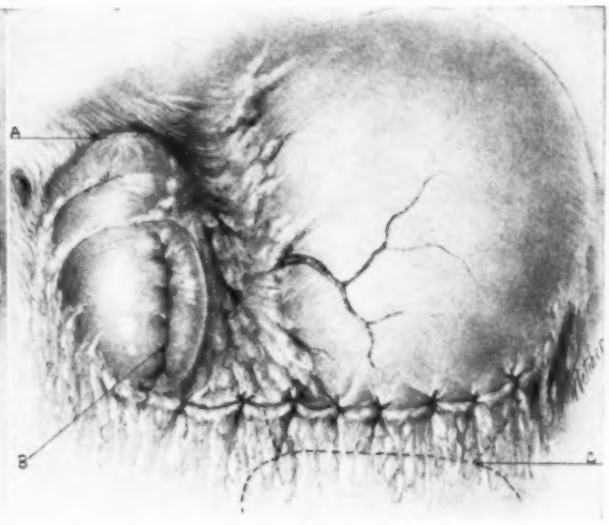


Fig. 9. Appearance of stomach and inverted antrum at completion of operation. A, Ulcer. B, Inverted antrum. C, Schematic sketch of retrocolic gastrojejunostomy.

the operative procedure complete. Follow-up roentgenographs show that with the anastomosis made as described above there is a free exit of the barium meal from the distal loop and no pocketing in the proximal loop. (Fig. 10.)

Success or failure of any operative procedure is largely dependent upon the ante-operative and postoperative therapy; therefore, the routine procedures are shown in Tables I and II. In the ante-operative therapy particular stress is laid upon the subcutaneous administration of fluid; in addition a gastric lavage the morning of operation is given in order to have a clean surface for anastomosis.

As the operation is frequently associated with an appendectomy and may take an hour and a half, the choice of anesthesia is important. Nearly all the cases have been done under ethylene and recently under avertin and ethylene. We have no objection to spinal anesthesia but feel that our results with ethylene have justified its continuance as the anesthesia of choice.

Postoperatively fluids are administered either subcutaneously or intravenously the day of operation and the first two days postoperative. It is our contention that fluids should be administered before there is definite indication, because once that time arrives it is often too late.

The use of the Levin tube inserted through the nares immediately after the patient has regained consciousness is a life-saving measure. The nurse is instructed to use a 50 c.c. syringe and to irrigate and suck out the stomach every two hours

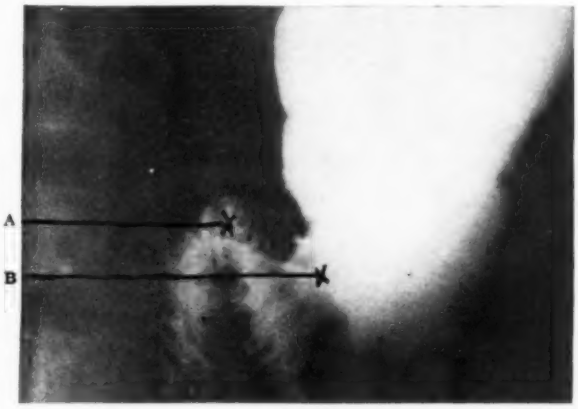


Fig. 10. Postoperative gastric radiograph. A, Beginning jejunum at fossa of Treitz. B, Stoma.

TABLE I
CASE ANALYSIS

Case Number	51817	51237	51191	50789	49829	45435	44134	41545	39919	36533	36106	33841	31269	53467
Duration of symptoms	8 yrs.	8 yrs.	4 yrs.	4 yrs.	4 mo.	7 yrs.	7 mo.	5 yrs.	1 yr.	2 yrs.	3 yrs.	5 yrs.	7 yrs.	1 yr.
Duration of medical treatment.	5 mo.	Sporadic	None	1½ yrs.	4 mo.	3 yrs.	None	5 yrs.	None	2 yrs. sporadic	None had op. for perf.	5 yrs. sporadic	None	1 mo.
Dental treatment	Proph.	Teeth O.K.	Teeth O.K.	Teeth O K.	Proph.	Extraction and proph.	Proph.	Teeth O.K.	Teeth O.K.	Teeth O.K.	Proph.	None	None	Teeth O.K.
Length of pre-op. treatment	½ day	1½ day	2 days	5 days	2 days	4 days	3 days	2 days	3 days	3 days	5 days	9 days	5 days	4 days
Pre-op. diet	None	Smithie 3 wk.	Bland	Smithie 7–14	Smithie 3–7	Gruel	High calorie	Soft	.....	Smithie	Regular	Sippy	Smithie	Sippy
Anesthetic	Ethylene	N_2O and ether	Ethylene	Ethylene	Avertin and ethylene	Ethylene	Ethylene	Ethylene	Ethylene and ether	Ethylene and ether	Ethylene	Ethylene	Ethylene	Avertin and ethylene
Associated operation	None	Chol'ectomy	Append.	None	Append.	Append.	Append.	Append. and chol'ectomy	Append	None	None	None	None	Append. and chol'ectomy
Hypodermoclysis	4	2	5	2	4	3	1	3–2	3	1	2	4	3	4
Wound infection	Hematoma	0	0	0	Appendix wound	0	0	0	0	0	Yes	0	0	Biliary fistula 8th day P.O.
Complications	0	0	0	0	0	0	Pneumonia	Int. obs. jejunostomy	0	0	0	0	Bronchitis	Lobar pneumonia
Out of bed	16	12	11	12	14	12	13	20	12	14	20	15	16	
Discharged	20	14	13	15	17	15	16	23	15	19	22	18	19	In hospital
Immediate result	Good	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good	
Late result	Good 4 mo.	Good 6 mo.	Good 6 mo.	Good 6 mo.	Good 7 mo.	Good 1 yr.	Good 1 yr.	Died 2 yr. intestinal obstruction	Fair 2 yrs. 50% relieved	Fair 2 yrs. good if on diet	Good	Good 3 yrs.	Good 3 yrs.	

day and night for the first forty-eight hours postoperative. The suction removes blood clot and gas and prevents postoperative vomiting and dilatation. When the washings return relatively clear in two successive irrigations the tube is removed, and if the operator is not certain of the condition of the stomach it is reinserted six hours later and suction and irrigation applied to be sure there is no dilatation. Table II gives the details of the postoperative therapy in this series.

TABLE II
POSTOPERATIVE ROUTINE

	Preop.	Day of op.	1st day postop.	2nd day postop.	3rd day postop.
Fluids by mouth	Forced	None	Aq. 1 oz. q. ½ h.	Aq. 1 oz. pep. mk. 1 oz. alternating q. 2 h.	Aq. 2 oz. pep. mk. 2 oz. alternating q. 2 h.
Fluids by rectum	None	5 oz. q. 3 h.	3 oz. q. 3 h.	3 oz. q. 3 h.	3 oz. q. 3 h.
Hypodermoclysis	Once	Once	Twice	As indicated	None
Lavage	Twice	q. 2 h.	q. 2 h.	As indicated	None
Enemas and colon irrigations	Enema twice	None	Colonic	Colonic	Colonic

REVIEW OF CASES

Immediate Postoperative Complications. There was no death in this series. There was one postoperative pneumonitis with an elevation of temperature for four days, with *x*-ray confirmation; one bronchitis, with suppurative sputum and elevation of temperature for three days, *x*-ray evidence showing peribronchial infiltration.

In the last patient operated upon under this procedure the operation was complicated by an appendectomy and cholecystectomy for numerous gallstones. On the eighth day the patient developed a biliary fistula complicated with a right lower lobe pneumonia. The biliary fistula as a complication does not seem attributable to the gastric operation. One patient had persistent vomiting for five days with apparently an obstruction of the distal loop of the stoma. Under local anesthesia a jejunostomy was performed, the patient was fed through this and made a relatively slow recovery. A further description of her case will be given under late results. There were two wound infections.

Late Complications. Two of the series, who had wound infections, showed incisional hernia on return to the follow-up clinic at the end of a year.

One patient died a year and a half postoperatively, of intestinal obstruction. This is the patient upon whom a jejunostomy was done following the operative procedure. She continued to have gastric and intestinal symptoms following the original operation and was treated by a very competent gastroenterologist in Chicago. A year and a half later, while I was out of the city, she returned with signs of intestinal obstruction and was operated upon by one of my associates. She had symptoms of persistent vomiting and pain in the epigastrium. At operation he found that the small intestines were dilated and congested. A jejunostomy was performed. She recovered slowly and was able to leave the hospital, although not completely well, and returned a month later with a second attack of vomiting and obstruction. At this time I operated upon her and performed a short circuiting operation between a distended and contracted loop. She developed further obstructive symptoms and peritonitis, and died. At postmortem examination in addition to a diffuse peritonitis it was found that there

was a herniation of a loop of jejunum just distal to the anastomosis through the mesocolon posterior to the stomach into the lesser sac. In reviewing this case with our follow-up, *x*-rays and history of her symptomotology, it seems evident that she developed this herniation shortly after her first operation and it had persisted in this position until her exodus.

At the time of the original operation the mesocolon was sutured to the anterior surface of the stomach but not to the posterior. It has been to the writer an object lesson of the necessity of suturing the mesocolon to the posterior as well as the anterior gastric surface in performing an anastomosis.

Follow-up. As shown in Table 1, 10 cases are reported as excellent, 2 as fair and one as poor, the patient having died of intestinal obstruction. One has been operated upon too recently to warrant any conclusions. Twelve of the 14 would recommend operation to any friend of theirs. Eight eat everything; 4 are well if they omit certain articles of food, such as fried foods and food with much residue. If they depart from their diet they have some gas and distress after eating, but nothing compared to the symptoms they suffered before operation.

CONCLUSIONS

The modification of the Devine operation in a small series of cases has proved to have a low enough mortality and satisfactory enough end results to warrant its use in postpyloric ulcers where the ulcers are adherent to the pancreas or in the neighborhood of the papilla of Vater. Its use is advocated in patients who have defied medical care and in those where there is no marked gastric retention.

I wish to express my thanks to Dr. Charles W. Lester for having tabulated the results and to Dr. Lewis Gregory Cole for much valuable advice.

TUMORS OF THE CECUM*

A DISCUSSION AND REPORT OF SEVENTY CASES

JOHN F. ERDMANN, M.D., F.A.C.S.

NEW YORK

IN a previous communication on this subject I reported with Harold E. Clark, my assistant, 48 cases operated upon by me in a few years preceding January, 1927, and from that date up to October, 1931, a period of four years, I am adding 22 cases, making a total of 70.

Among the more common tumors of the cecum appearing in the literature of the day are the cystic, including dermoid, epidermoid and entero-cystoma, and the limomyoma, actinomycosis, and lymphosarcoma, while standing out most prominently are carcinoma, tuberculosis, chronic inflammatory hypertrophy and the occasional lymphosarcoma. These growths from carcinoma to lymphosarcoma are mentioned in the order of frequency as seen by me.

Carcinoma was found in 56 cases, tuberculosis in 9, chronic inflammatory in 2, lymphosarcoma in one, polyposis in one and undetermined pathology in one.

While the pathology of the "undetermined pathology" cases and several of the tuberculous was in doubt, evidences of tuberculosis or manifestations allied to tuberculosis caused me to add them to the tuberculous.

Twice I have had actinomycotic associations with the cecum. One was in a case of appendicitis with mass formation. The patient was operated upon and a gangrenous appendix and a large abscess were found. Persistent sinuses followed with a final finding of actinomycosis organisms. Liberal doses of potassium iodide were instituted. So far, for a period of eight years, no further evidence has manifested itself.

Another case, seen lately, has been diagnosed in the West as actinomycosis. There was a history of appendicitis and operation followed by a large pelvic mass almost filling the pelvis. On examination by me there were two large granulating areas in the lower right quadrant and the buttock of that side. The patient was in a most pitiable state.

These two cases are not included in the list of tumors as I did not consider the first as a primary actinomycotic growth and the second was not an operative patient of mine.

For the sake of completeness, a brief review of anatomy with emphasis on the cecal lymphatics is necessary.

ANATOMY

In a normal adult the cecum is about 2½ inches in length. A fold running from the top of the ileum partly around the large gut marks the boundary between the cecum and the colon. The cecum differs from the rest of the large gut in that it is more richly supplied by the lymphatics. It is lined with a single layer of columnar cells. Villi and valvulae conniventes are absent.

The vessels of the mesentery and nerves enter the cecum and colon from the inner or left side. This may be explained embryologically since the cecum and the colon originally occupy the left lower abdominal segment; later they rotate to the right, remaining permanently in the right iliac fossa.

The blood supply to the cecum is the ileocolic branch of the superior mesenteric. The ascending colon is supplied by the

* Read before The Academy of Surgery of Detroit, Michigan, Dec. 10, 1931.

right colic and the transverse colon by the medial colic artery.

The lymphatic drainage follows the course of the ileocolic blood vessels. Frequently they are continuous with glands around the superior mesenteric artery. The terminations are associated with the ileocolic arterioles.

Lymph channels surround the glands of Lieberkühn where carcinoma of the cecum originates. From there they are directly continued to the network of the lymphatics in the submucosa. These pass through the muscle layers and form plexuses of lymphatics between the mesenteric sheaths.

The lymph systems may drain into five different groups of glands about the cecum or directly into the glands around the ileocolic artery above.

The groups as given by Craig and MacCarty are: (1) Anterior colic. (2) Posterior colic. (3) Appendicular. (4) Illeal. (5) Right colic.

LYMPHOSARCOMA

Lymphosarcoma is an extremely rare disease of the cecum. During a period of fifteen years in Prague of 13,036 sections 13 cases were found. It does, however, occur with more frequency in the small intestines and the rectum.

The symptoms are similar to other types of cecal tumor occurring in early adult life. The tumor is extremely rapid-growing and non-tender. It begins in the submucosa made up of small or large round cells. Within a very short time the entire gut wall is infiltrated. The central portion breaks down and ulcerates. Extension takes place peripherally. With sarcomatous invasion the gut has a tendency to be dilated rather than to be constricted in contra-distinction to carcinoma. Polypoid excrescences are not usual.

The course is rapidly fatal. Metastases occur early in the contiguous lymphatics and likewise in the distant organs.

Early recognition and excision followed by roentgen and radium therapy offer the best prognosis. A few cures have been reported.

In our series we had one case reported to be lymphosarcoma.

TUBERCULOSIS

There is now a rather general agreement that tuberculosis does occur primarily as well as secondarily in the cecal region. The pathological differences are quite marked. This in a given case together with absence of tuberculous foci in other regions furnishes strong support for those contending primary invasion.

Tuberculosis of the cecum is very common in patients having pulmonary involvement. At necropsy it has been demonstrated that the gastrointestinal tract is involved in 70 to 90 per cent of these cases (Hartman quoted by Menzies). Of this number the ileocecal region is involved in about 85 per cent of the instances. Only a relatively small number of this group receive surgical interference, and then only when symptoms of obstruction, fistulae and severe subjective signs are present.

The best explanation offered for the predilection of the ileocecal region is based on anatomy. As cited previously, the cecal region of the large gut, excepting the rectum, is the most abundantly supplied with lymphoid tissue. In children the infection is attributed to milk inoculation by the bovine type of bacillus. In adults it is ingested with the food, or transmitted through the blood stream, the organism being the human type.

The age incidence is early adult life between the second and third decades, although of our series of 7 cases reported, the average age was under twenty years. As regards sex, the distribution was equal.

There is nothing in the symptomatology characteristic of tuberculosis unless it be the insidious onset, chronicity and interval period of freedom from symptoms. The duration in our series extended from two months to five years.

Pain is an early evidence; distress at first, later cramp-like and irregular. Associated with this is tenderness and rigidity in the right lower quadrant. Obstinate constipation with diarrhea and blood-streaked mucous shreds is a prominent symptom. Epigastric discomfort, nausea, vomiting and belching occur early. The absence of temperature means little. Its presence, particularly in the afternoon, may augment the differential diagnosis.

Serum tests in adults are of very little aid. Pulmonary, osseous and glandular involvement must always be sought for. We were able to demonstrate phthisis in one instance, no extracecal focus in the others.

Brown, Levy and Haft all emphasize the difficulty of clinical recognition and stress the value of the roentgen examination.[1] Brown reports that in 28 cases diagnosed and operated, 27 were correctly diagnosed. His work upon this subject has been painstaking and most illuminative. The roentgen picture in cecal tuberculosis reveals hypermotility, spasticity and filling defect. Obstruction, when present, is likewise disclosed.

Pathologically there are two distinct types of cecal tuberculosis, ulcerative and hyperplastic.

Ulcerative Tuberculosis. Menzies describes this type as the enteroperitoneal group. The tubercles are first found in the mucous membrane. As they grow they coalesce, undergo central degeneration and produce superficial flat ulcers with undermined edges. Read states that the ulcers circle the gut because the lymphatics and vessels run circularly. As a result, when healing occurs, the cicatrix forms an obstructing band. He maintains that 25 per cent of the ulcerous type produce stricture or stenosis. Similar tubercules in the serosa produce a dense adhesive peritonitis. This group is considered a secondary manifestation of a primary focus elsewhere. It is surgical only when obstruction makes intervention imperative.

[1] Also, see the article by J. W. Larimore and A. O. Fisher, *Ann. Surg.*, 83: 496, April, 1926.

Hyperplastic. This group is considered to be primary in origin. Surgical excision frequently perfects a cure. The tubercles appear in the submucosa, growing there, causing thickening of the wall and narrowing of the lumen. Menzies claims that by the fibrolipomatous changes in the pericecal fat there is a tendency to self-limitation of the tumor.

Our cases represent both these types of tumor. It was observed that secondary infection had played an important part in the syndromes. All cases showed degrees of obstruction. Five were of the hyperplastic type, one of which was complicated by a fecal fistula. Two showed papillary projections of the mucous membrane. One was of the ulcerous, constricting type with the primary focus in the right middle lobe of the lung. It is interesting to note that all had, at various times, been diagnosed as appendicitis. Two had had appendectomies, one of which resulted in the fecal fistula mentioned above, the fistula being the result of a primary perforation of a tuberculous ulcer of the cecum.

A Friedreich resection with a side-to-side anastomosis of the ileum to the transverse colon was done in one stage in three instances. Because of the extreme dilatation of the ileum in the ulcerative case only the resection of the tumor and an ileostomy (Paul's tube) was attempted at the first stage. Eleven days later the anastomosis was completed similar to the others.

The results were uniformly good. There was one death out of 7 patients, a child two and one-half to three years old, with tuberculosis of the cecum who had an appendectomy done; the other patients left the hospital apparently cured. Responses to follow-up letters revealed freedom from symptoms and marked general improvement.

CARCINOMA

In this series of cases the youngest was twenty-one and the oldest seventy-eight.

Attention has been called to the fact that carcinoma of the intestinal tract occurs with far greater frequency in the foregut and the hindgut. The midgut, extending from the second portion of the duodenum to the ileocecal valve, is relatively free from invasions. It seems, therefore, that that portion of the gut functionating to prepare and digest food and also that portion which has to do with the storage and evacuation of unassimilated food is peculiarly susceptible to carcinomatous invasion.

Brill (quoted by Ewing), in reporting 3563 cases of malignancy of the intestines, found only 89, or 2.5 per cent of instances in which the small intestines were involved. Of this number the greatest percentage occurred in the second portion of the duodenum about the biliary pailla.

In an article by myself and R. F. Carter,[1] the senior author reports the following frequency of malignancies of the colon in a series of 129 cases: 50 in the rectosigmoid, rectum and anus, 37 in the sigmoid, 18 in the cecum, 15 in the ascending colon, hepatic flexure and right half of the transverse colon and 9 in the left half of the transverse colon and splenic and descending colon.

Tissue predisposition is evident in those instances in which malignant changes develop from polyps of the colon. Trauma due to physiological and anatomical relationships plays a definite role. No doubt these portions of the gut which are fixed and offer more resistance to fecal movements are subjected to a more constant irritation. This resistance probably is greatest at the ileocecal junction and at the rectal valves.

Pathology. Tumors of the cecum are characteristic of tumors elsewhere in the colon. They are slow growing, only moderately malignant, extending late and metastasizing less frequently than tumors of a similar nature in other organs.

Carcinoma begins in a circumscribed area of mucosa, with enlargement of the glands and permeation of the basement membrane. This area gradually extends by progressive transformation of normal into neoplastic alveoli. Microscopically this process can be demonstrated and one may frequently see papillary outgrowths of mucosa surrounding an ulcerated tumor.

Ewing gives the following gross and microscopical classification:

1. Adenoma Destruens: A bulky ulcerating tumor causing obstruction, fistulae and anastomosis.

2. Stenosing Fibrocarcinoma: First produces a superficial ulcer with marked fibrotic induration. It has a tendency to be annular, causing con striction of the lumen and infiltrating tissue and nodes early.

3. Colloid Gelatinous Adenocarcinoma: Bulky, spreads rapidly and ulcerates early. This type produces miliary nodules in the peritoneum. Lymphatics are involved later.

4. Multiple carcinoma from polyposis.

5. Papillary carcinoma from single polyps.

6. Melanoma.

Colloid carcinoma or gelatinous of Ewing differs from adenocarcinoma only in that it is a degenerating form. Parhan describes it as lack of functional control of the secreting epithelial cells. This functional differentiation of cells corresponds to morphological differences seen in carcinoma cells of the acinar or columnar type. He observed colloid carcinoma in 22 per cent of all malignancies of the cecum. In our series,[1] with a recent pathological "check-up" of specimens, we found only 18 per cent conforming to the type.

Metastasis is rather late and recurrence is usually found at the site of origin. Death may be delayed in colloid carcinoma but the eventual mortality is greater than in other types. Parhan points out that the signet ring cells tend to be more malignant than the glandular type with columnar growth.

The most frequently involved group of lymphatic glands are the posterior colic.

[1] *N. York, M. J.*, 115:649, June 7, 1922.

[1] *Ann. Surg.*, 85:722, May, 1927.

In the Craig and MacCarty series of 100 cases studied with particular attention paid to glandular distribution, 71 per cent of all glands found were in this region, and 64 per cent of the glands showing metastatic involvement belonged to this group.

This may be explained by the frequency of involvement of the ileocecal valve in malignancy of cecum (50 per cent, Ewald, to 65 per cent, Craig), posterior wall alone in 35 per cent. When the valve was involved in the growth and regional metastases were found, the posterior colic chain showed tumor cells in 78 per cent. The surgical significance of the group is at once apparent.

Craig and MacCarty concluded: "The size of intestinal lesions and the size and number of regional lymph-glands proved to be no criterion for the presence or absence of metastasis." They found regional glandular involvement in 32 per cent of their 100 cases.

Many glands are hyperplastic, edematous and simulate malignancy, only to be found on biopsy to be inflammatory reactions. In our former series in 25 per cent we were able to demonstrate carcinomatous infiltration. Furthermore, cases which clinically are of the low malignant variety tend to have larger and more numerous hypertrophic glandular changes. When the glands are involved in the carcinomatous process clinically the picture is more severe and the prognosis as to cure much more unfavorable.

Secondary infection invades tumors early and plays a leading part in the rapidity of growth and formation of fistulae and production of peritonitis. The tumor seldom is the direct cause of death. Cachexia and the resultant death are due primarily to superimposed infective processes. This is especially true in the cecum; in this region the bacterial fermentative and putrefactive processes reach a maximum of activity. Given the seed for inflammatory reaction it follows that they will grow rapidly in gut soil already weakened in resistance by malignant degeneration.

In the earlier communication Erdmann and Clark found regional gland metastases in 25 per cent of the reported cases. The ileocecal valve was involved in about 48 per cent of instances, and one-half of these showed lymphatic invasion. The entire wall was infiltrated in 62 per cent. Ulceration was present in about 40 per cent. Five specimens revealed infiltration of a portion of the appendix. Multiple polyps were present in 6 instances.

Distant metastases in other viscera outside of the colon were not discovered. The liver was never found to be the seat of secondary growths. This is in accord with other observers.

Signs and Symptoms. Seldom is the surgeon consulted in the incipiency. Rarely do the symptoms manifest themselves before secondary inflammation or obstructions occur.

This fact is clearly demonstrated by our series in which the earliest duration of symptoms was given as ten days. In delving into the past history, however, the patient admitted having had indefinite pain in the right lower quadrant for four years, melena irregularly for one year, and loss of 10 to 15 pounds in weight during that period.

He appeared before me two days after an acute attack of pain, nausea, vomiting and detection of a mass 6 c.c. in diameter in the right abdomen. At operation a very extensive carcinomatous process was found. The tumor began in the cecum, involved the valve and extended into the proximal portion of the colon. The lumen was filled with ulcerated papillary projections and the entire wall infiltrated by the growth.

The longest duration of symptoms was fifteen years. This patient had complained of mild "stomach trouble" for that length of time. Three weeks previous to admission he had noticed a mass and then had consulted a surgeon. The average duration of symptoms was one and one-half years to two years.

The symptoms are actually due to secondary complications and may be divided into subjective and objective signs:

A. *Subjective Signs.* We include in this group pain, constipation alternating with diarrhea, distention, nausea, vomiting and weakness.

Pain, admittedly a late symptom, was present in 80 per cent of our cases. About one-half of the number maintained it to be the first indication of disease. It was described usually as a gradual onset of a dull ache. The location most often mentioned was the right side, chiefly the right lower quadrant or just to the right of the umbilicus. Radiation was inconstant, either absent or down the right leg or toward the umbilicus. Food held no relationship to it. Pain increased in severity during the night hours. Evacuation of the bowels gave the most relief. The pain, beginning gradually as a dull ache, steadily increased in character to colicky attacks and sharp piercing qualities. This development may be due to various phases of pathology, beginning with ulceration through obstruction and to the penetration of the peritoneal nerves by the tumor mass.

Constipation, increasing in severity, was declared the next most frequent symptom. Alternating diarrhea was mentioned in only three instances, which leads us to conclude that it is not so characteristic of cecal tumor growths as it is of tumors more distal in the colon.

Distention, *nausea* and *vomiting*, all signs of degrees of obstruction, occurred with about equal frequency in about one-third of the cases observed. Weakness and anorexia were present in approximately the same number.

B. *Objective Signs.* In this group we include loss of weight, presence or absence of mass, tenderness, melena, stiffening of gut, visible peristalsis and anemia.

Loss of weight was present in about 79 per cent of instances, varying in amount from 5 to 30 pounds. Associated with this there was severe weakness and anemia. The average hemoglobin reading was 69 per cent; the red cells numbered 3,900,000. About an equal number of cases showed either a corresponding diminution in the white cell count or a slight leucocytosis seldom exceeding 11,000. A mass was found in one-half of the cases, usually fixed to a degree, posteriorly. With one exception tenderness was always elicited when a mass was present.

Melena, a rather constant finding in tumors higher in the colon, was present in one out of 4 cases. A search for occult blood should be made, however, as we feel that a positive finding is less frequent in cecal growths.

Stiffening of the gut, excluding masses found, and visible peristalsis were noted frequently.

In addition to the foregoing signs and symptoms we have the aid of the roentgen ray. It is impossible not to regard roentgen-ray examination of paramount importance in suspected cecal disease. Unquestionably in the detection of early involvement it stands first in value as an aid in diagnosis.

In our series, in every case subjected to roentgen examination, either with the preliminary and in the vast majority of instances an accurate diagnosis was made preoperatively.

The usual findings in cecal carcinomata were a filling defect or a change in the normal contour. A lack of contrast mixture in the cecum was a frequent finding. Absence of peristalsis in the cecum with hypermotility in the colon was a very constant picture. In addition, distention of the distal loops of ileum was found with varying degrees of obstruction.

Operation. We prefer the Friedreich operation for tumors of the right side of the colon and consequently have followed this technique in 46 of the cases reported. It consists of the removal of 10 to 12 inches of the ileum, the entire cecum, the ascending colon and from one-third to one-half of the transverse colon, completed by an anastomosis of the ileum to the transverse colon, end-to-end being the choice. A side-to-side anastomosis is the

operation of choice in the very fat endowed colon. End-to-side anastomosis was done in 3 of the recorded cases.

In the previously reported cases we had not had occasion to use the methods of precaution against gas distention as advocated by Dr. Charles Mayo. In the past four years I have made an enterostomy in several cases.

Results following the Friedreich technique have justified our preference for it. Of the 28 cases previously reported we had 6 deaths, or a mortality of 21.4 per cent. The postoperative convalescence was relatively easy, and the follow-ups were satisfactory.

Ileocolostomy was resorted to on 5 occasions, 2 with anastomosis of the ileum to the transverse colon and 3 of the ileum to the sigmoid. One patient had had an ileosigmoidostomy made six months previously which was not disturbed at the second operation when removal of the growth was done. On three occasions the growth was not resected; only a palliative short circuit was attempted. There was one recurrence in a patient from another city, producing obstruction two years after operation, in whom an ileosigmoidostomy was done.

A delivery of the tumor after the method of Mikulicz and subsequent closure of the artificial anus resulted in one death out of 2 cases.

Four instances of complete intestinal obstruction rendered resection impossible and a temporary ileostomy was made with a Paul's tube inserted into the ileum, resulting in two deaths.

A plastic on the cecum with local resection of a benign tumor was done in one instance and resulted in permanent cure. This is not added to the total number.

We were unable to find the type of operation done in one case with carcinoma complicated by obstruction which resulted in a mortality. In two instances appendectomies had been done within a period of five years and both patients stated that they had not been feeling well since that time. At operation in each instance the growth was very extensive. This might suggest the possibility of an early tumor presenting the symptoms of an inflamed appendix and having been overlooked. Attention to such has been cited by myself in a previous communication.

Another patient had had a resection of a portion of the transverse colon eight years before and was entirely well until six months before I saw him. At operation an extensive colloid carcinoma was found with regional glandular metastases. Moreover, in the colon, 49 cm. from the cecal growth, a nodule 25 × 10 mm. was found to be of similar pathology. Here again, since we know that colloid carcinoma is sluggish in growth, we may infer that the cecal tumor might have been present and passed unnoticed by the operator.

SUMMARY

Seventy operated cases of cecal tumor are studied in this report. Carcinoma was found in 56 instances, tuberculosis in 9, chronic inflammation in 2, lymphosarcoma in one, polyposis in one and one of undetermined pathology.

Other tumors occasionally found are cyst, gummas, lipomas, tuberculomas, papillomas, cholesyteotomas, liomyomas and actinomycoses.

The ileocecal region is the site of predilection for tuberculosis because of the right lymphatic supply.

Five of the 9 tuberculosis cases were of the hyperplastic type without a demonstrable primary focus. One had an involvement of the right lung and the cecal growth was considered to be secondary. Three others were tuberculomas.

The Friedreich resection was performed in all the tuberculous tumors with no mortality and a symptomatic cure. Only an appendectomy was done in 3 tuberculomas.

The cecum has a predisposition to malignant degeneration because of its physiological and anatomical relationship.

Regional glandular metastasis was found in 25 per cent. of the cases previously reported. The ileocecal valve was involved in 48 per cent.

The signs and symptoms most frequently found were pain, loss of weight, a mass and marked anemia. Roentgen examination was the most accurate aid in diagnosis.

The Friedreich operation was the method of choice, being performed in 47 of the 56 cases of carcinoma, with a mortality of 21.4 per cent. in 37 cases reported previously. Of 22 cases since January, 1927, 12 were male, 8 were female and 2 of sex not recorded.

CONCLUSION

Carcinoma is the most frequent cecal tumor requiring surgical intervention. Lymphosarcoma is the most highly malignant tumor.

Cecal carcinomata are slow growing and only moderately malignant. Secondary infection invades the tumor early and is the chief cause of the profound cachexia found in these cases.

Distant metastases are rare in carcinoma of the cecum.

Secondary intestinal growths are not uncommon and should always be sought for. A malignant tumor obstruction may simulate a chronic appendicitis.

BIBLIOGRAPHY

SISTRUNK, W. E. Carcinoma of caecum and ascending colon. *S. Clin. N. America*, 5: 725–729, 1925.

SEVAN, T. S. Case of lymphosarcoma of caecum. *Radiology*, 5: 71072, 1925.

HAGYARD, C. E. Lympho-sarcoma of appendix and caecum. *Northwest Med.*, 24: 342–344, 1925.

HUMISTON, C. E., and PIETTE, E. C. True cholesteotoma fo caecum. *J. A. M. A.*, 84: 874–876, 1921.

JOYCE, T. C. Carcinoma of the caecum. *S. Clin. N. America*, 4: 1337–1338, 1924.

PODALKA, J. Leiomyoma of the caecum. *J. A. M. A.*, Abstract, 82: 1962, 1924.

CRAIG, McK. W., and MACCARTY. Involvement of lymph glands in cancer of the caecum. *Ann. Surg.*, 77: 698–710, 1923.

PIERSOL. Human Anatomy. Ed. 7, Phila., Lippincott, 1919, pp. 115–123.

GRIFFETH, F. W. Actinomycosis of the caecum. *Surg., Gynec. Obst.*, 33: 538, 1921.

HINGLAIS, M. Adenomycosis of the caecum and appendix. *Intern. Clin.*, 3: 59, 1921.

HARTWELL, J. A. Non-tubercular inflammation of the caecum. *S. Clin. N. America*, 1: 361, 1921.

READ, W. D. Tuberculosis of the caecum. *Northwest Med.*, 20: 282, 1921.

EWING, J. Neoplastic Diseases. Ed. 2, Phila., Saunders, 1922, p. 661.

MAYO, C. H., and HENDRICKS, W. A. Carcinoma of the right segment of the colon. *Ann. Surg.*, 83: 357, 1926.

CHOYCE, C. C. System of Surgery. N. Y., Hoeber, 1923, 1: 523.

PARHAN, D. Colloid carcinoma. *Ann. Surg.*, 77: 90–105, 1923.

MENZIES, C. S. Tuberculosis of ileo-caecal region with special reference to the caecum. *Northwest Med.*, 21: 406, 1922.

COFFEY, *Internat. Clin.*, 4: Sec. 31, 1921.

MUMMERY, J. P. L. Diseases of the Colon. N. Y., Wood, 1910, p. 322.

BROWN, L., and SAMSON, H. L. The early roentgen diagnosis of ulcerative tuberculous colics. *J. A. M. A.*, 73: 77–85, 1919.

ARCHIBALD. *Am. Rev. Tuberc.*, pp. 433–449, October, 1917.

READ, W. D. Caecal pathology. *Northwest Med.*, 20: 11, 1921.

ERDMANN, J. F., and CARTER, R. F. Malignancies of the colon. *N. York M. J.*, 115: 649, June 7, 1922.

FASCIAL TRANSPLANTS FOR CLOSURE OF THE ORIFICE OF UMBILICAL HERNIA*

G. PAUL LAROQUE, M.D., F.A.C.S.

RICHMOND, VA.

THERE have been many operations devised for the closure of the orifice of umbilical hernia, most of which are characterized by overlapping of the fascia of the abdominal wall. If this can be done in such a way as to avoid tension on the line of sutures, the operation is likely to be followed by cure.

It is idle, however, for surgeons to claim that the results following this method of procedure are uniformly successful. If patients are examined one to five years following operation, there will be found a great many "recurrences"; and at the second opration, the edges of the fascia which have previously been sutured will be found widely separated.

The use of fascial transplants sutured properly in the canals and orifices of hernias of large-size and difficult to cure is now recognized as a valuable contribution to the technique of operations for hernia in all parts of the abdomen and is extensively employed. The experimental work of Gallie several years ago demonstrated the permanency of such grafts.

Utilization of a fascia lata transplant, placed according to the method herein illustrated, avoids tension and insures permanency of closure. The illustrations show the method without further description. I have employed this method in many cases and now long enough to be sure of final results. The method seems to fulfill the fundamental requirement of adequate closure with tissue grafts, sutured into accurate position without tension, and is submitted to surgeons as a better method than simple overlapping.

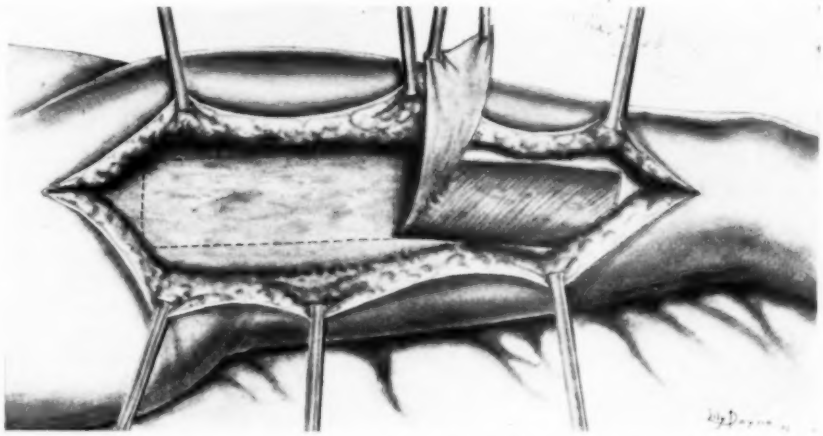


FIG. 1. Incision in thigh for removal of a piece of fascia lata 1½ inches wide and 8 inches long.

A piece of fascia lata at least 1½ inches wide and 8 inches long is removed by the usual incision in the thigh. This piece of fascia is cut into two equal pieces, each 1½ inches wide and 4 inches long. These are kept in salt solution until ready to be sutured into place.

A skin incision transverse and elliptical in shape is made through the skin and fat of the abdominal wall down to the fascia, covering the recti muscles, the fat is brushed from the fascia for a distance of 2 or 3 inches around the hernial orifice, and

* From the Department of Surgery of the Medical College of Virginia. Submitted for publication July 10, 1931.

the neck of the peritoneal sac is exposed and opened. Bowel and omentum if adherent to the sac are freed, all points of possible bleeding are ligated, and returned to the abdominal cavity. If necessary, the fascia forming the hernial orifice may now be divided on each side in a lateral direction. Frequently, however, this is unnecessary. The peritoneum about the margin of the orifice, if not too thin, may be gently separated from the overlying fascia. Usually the peritoneum is so thin that to attempt to separate it causes tears of the peritoneum. If it can be separated, however, it can then be sutured in a transverse direction, and the fascia transplant made in the space between the peritoneum and the deep fascia. I have in some cases allowed the peritoneum and fascial layers to stay together, and put the fascia transplants in position under the peritoneum. In either case, the two transplants are placed in position as indicated in Figure 4 through a separate cut an inch or more beyond the margin of the orifice, the ends of the transplant are drawn through and sutured in position. This makes an adequate closure of the orifice with two patches

FIG. 2.

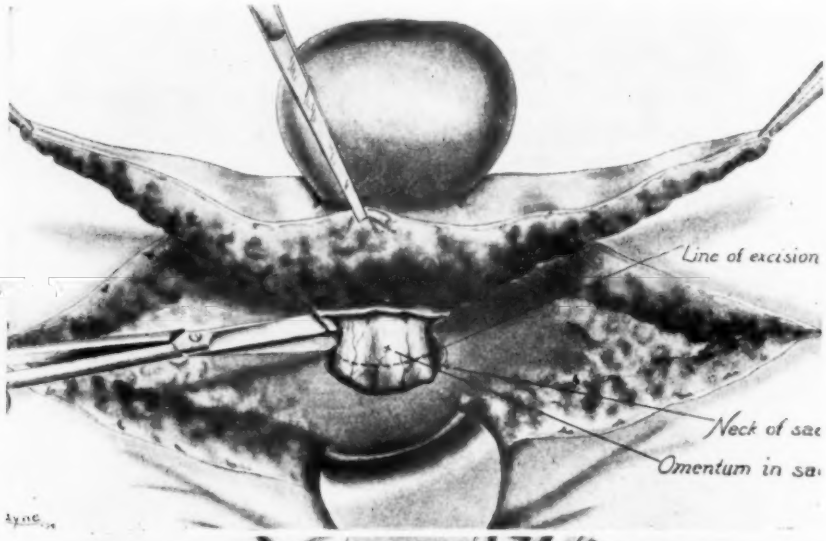


FIG. 3.

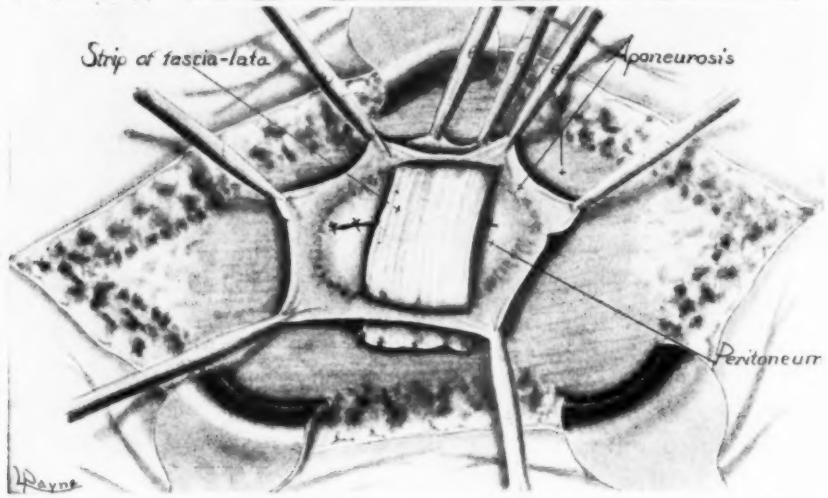


FIG. 2. Removal of umbilical hernia containing incarcerated omentum. Transverse incision, omentum ligated, and sac being excised. Omentum will be cut across at dotted line.

FIG. 3. Excess of sac has been removed, omentum drawn back, peritoneum closed. One patch of fascia lata in position to be sutured.

of fascia, placed in opposite directions, like a cross. The skin edges are then sutured.

I have had the opportunity to examine 2 cases which served as good tests for the efficiency of the operation. One woman operated upon while three months pregnant went through the remainder of pregnancy and normal labor, without recurrence of the hernia. The other case was that of a tremendously obese woman in whom there occurred some wound infection followed by a draining sinus. Eights months following operation the sinus was excised; three silk sutures were removed. This gave opportunity to inspect the field of operation, where it was found that the fascia patches were firmly intact, and no hernia recurrence.

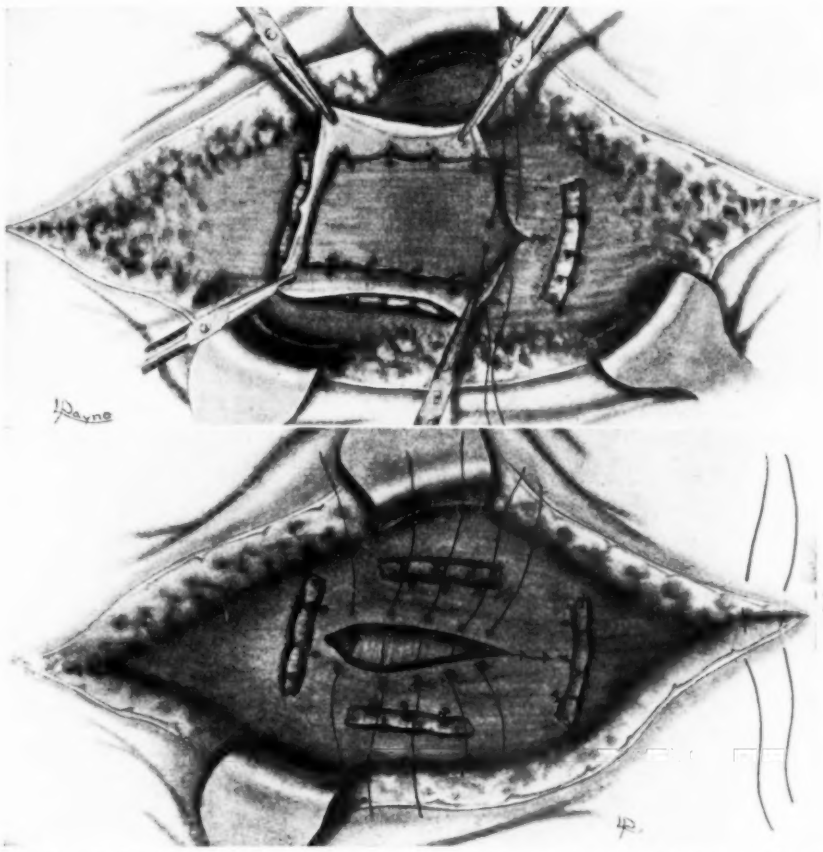


Fig. 4.

Fig. 5.

Fig. 4. Second patch of fascia lata has been put in position in a direction opposite to the first, and fibrous portion of remainder of sac is being sutured.

Fig. 5. Both pieces of fascia lata are sutured in place and fibrous part of remainder of sac is sutured over fascia lata.

THE IMPRACTICABILITY OF USING

FASCIA FOR THE GRADUAL OCCLUSION OF LARGE ARTERIES*

HERMAN E. PEARSE, JR., M.D.

ROCHESTER, N. Y.

AN ideal method for the progressive obstruction of the great vessels has never been achieved. At first clamps or snares, which protruded from the wound were used. These usually resulted in the formation of an infected sinus with occasional secondary hemorrhage. Halsted[2] devised the first aseptic method and with the exception of its use on the aorta, his partially occluding aluminum band is the best device today. The methods proposed attempt to accomplish the object in three ways. First, by exerting pressure on the outside of the vessel wall. This is done by the Halsted band, the Matas band[5] the Neff clamp[8] and by tapes, ligatures, strips of fascia, pieces of aorta, or Baer's membrane. The disadvantage of this procedure is that the thrust of the expansile pulsation pushing against the compressing device weakens and may rupture the vessel. Second, by plicating the arterial wall with sutures at successive operations. Matas and Allen[5] and Reid[10] have tried this method. Its disadvantage is that with disease of the vessel the sutures do not hold well. If they tear out hemorrhage result obstructing the lumen from within. A method has been proposed[9] for inducing gradual thrombosis by means of a coiled spring which is screwed into

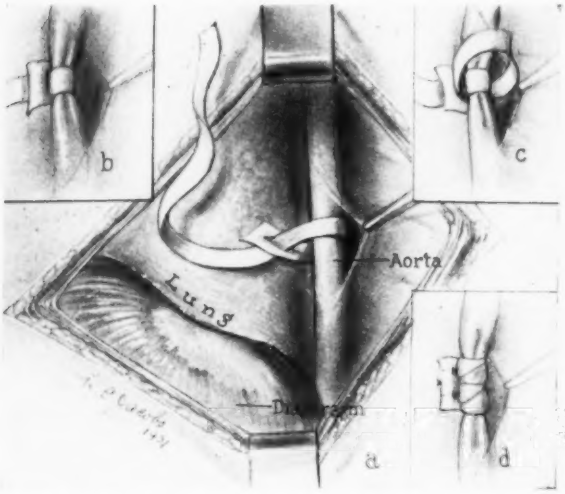


FIG. 1. Method of applying fascia to thoracic aorta. *a*. Strip of tissue is placed beneath vessel and threaded through a slit in one end. *b*. It is pulled tight to obtain desired amount of constriction. *c*. Successive turns are taken by passing strip through slit at each revolution. *d*. After six or eight turns have been placed, two ends are fixed by silk sutures. Care is used to prevent sutures from coming in contact with arterial wall.

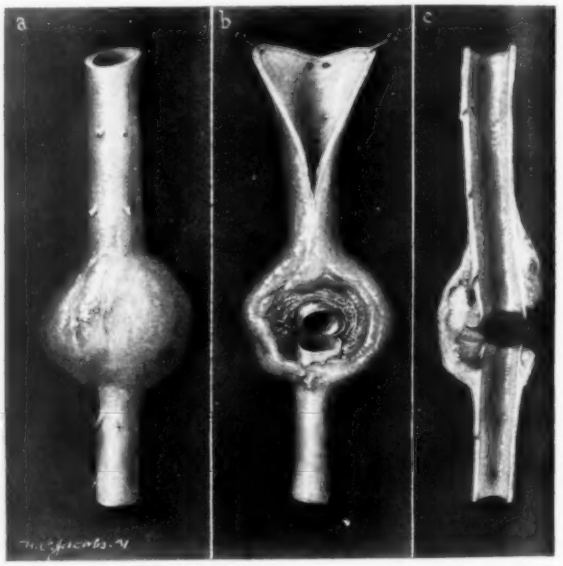


FIG. 2. Rupture of thoracic aorta ten days after application of a partially obstructing fascial band. *a*. Mass of connective tissue which surrounds vessel. *b*. Opposite side showing nearly complete absence of continuity of lumen. *c*. Longitudinal section to show attenuated wall at site of constriction.

* From The Department of Surgery, The University of Rochester School of Medicine and Dentistry.
Submitted for publication July 6, 1931.

the lumen. Reid[10] has advocated a fascial plug with a tube in its center which is placed within the artery. The disadvantages of these methods are the possibility of hemorrhage at the time the vessel is opened and the danger of peripheral embolism. The latter has never been observed but is a theoretical possibility. It is felt that the aorta can best be occluded by some sort of internally obstructing device which does not place a strain upon the vessel wall.

Since an ideal method for gradual occlusion of the large arteries has not been achieved, continued experimentation on the subject is desirable. It is conceivable that the universal property of scar tissue to contract could be put to use here. If after first partly constricting the vessel at operation, enough scar contracture could be induced, complete obstruction would result. This process might be tested by encircling the artery with large amounts of fascia in the hope of producing fibrosis. Past experience with the use of fascia as a partially occluding agent has been disappointing. It was first tried by Halsted[2] and Nassetti[7] working independently. Halsted says:

> Fine silk cut through in two days; coarse silk cut through more slowly, knotted ligatures were found to be unsuitable, for a desired degree of constriction or obliteration could not be accurately obtained nor could the crushing of the arterial wall be invariably avoided. Tapes of various materials were tested—of cotton, of chromicized intestinal submucosa, of elastic tissue obtained from the raota, of aponeurotic white fibrous tissue. These were applied in spiral or cuff form.

These tissue bands always relaxed and allowed reestablishment of the lumen. Brooks[1] tied the human aorta with fascia lata and at autopsy three months later found that it had relaxed. McNealy[8] and Lichtenstein[6] have advocated attaching the fascia to muscles on each side of the vessel. Reports by Hitzrot,[4] Hanford and Wheeler[3] and Scheffelaar-Klots[11] discuss the use of tissue bands for partial occlusion of the large arteries. It has been the usual experience that one or two turns of fascia about an artery always relax to allow re-

Fig. 3. Erosion of arterial wall at site of contact with a silk stitch. Halsted reports a similar experience.

establishment of the lumen. It was hoped that by using multiple turns about the vessel enough periarterial support would be obtained to prevent relaxation and even to increase the constriction by fibrotic contracture. Consequently the aorta of dogs was encircled and partially constricted by six to eight turns of heavy fascia. This gave a mass of connective tissue about the vessel. It was found that even this relaxed and in some cases it so weakened the wall that rupture followed. Thus fascia is not only unsatisfactory as a partially occluding agent but also is potentially dangerous in its effect.

METHOD

Adult dogs which received ¼ grain of morphia and ether anesthesia by tracheal insufflation were used as test animals. At first the fascia was obtained from the anterior rectus sheath but later the material was taken from the tendon of the erector spinae muscles. A strip ½ inch wide and 6 or 7 inches long was excised. After all fat, muscle and areolar tissue had been removed, a slit was made about ⅜ inch from one end. Having prepared the fascia in this manner, it was wrapped in moist gauze, the wound was closed and the primary operative procedure was done. In ten of the animals the thoracic aorta was occluded while in six the abdominal portion below the renal arteries was obstructed. The thoracic aorta was exposed through an intercostal incision in the eighth left interspace. After opening the chest the parietal pleura was incised and the vessel picked up. The strip of fascia was passed beneath it and the end was threaded through the slit in the opposite end (Fig. 1 A). It was pulled tight enough to obliterate the peripheral pulse while leaving a faint thrill on the distal side (Fig. 1 B). This tension was maintained and the successive turns about the vessel were taken by passing the strip through the slit at each revolution (Fig. 1 C). After six or eight turns the ends were fixed with silk sutures (Fig. 1 D). The abdominal aorta was exposed through a muscle splitting incision in the left flank. After the peritoneum was opened the kidney was picked up and tension made on the renal artery. This gave a guide to the aorta which was freed by retroperitoneal dissection. After the vessel had been isolated it was partially obstructed by fascia in the same manner as was the thoracic portion.

The animals that survived were sacrificed in from one to four months after operation. The entire arterial tree was injected with a suspension of 20 per cent barium sulphate in 10 per cent gum acacia through the carotid artery after exsanguination. The animals were placed in a refrigerator for six hours to allow the injection mass to harden. The thoracic and abdominal viscera were then removed and roentgenograms made of the somatic arteries. The operative specimens were removed and examined. In this way evidence of the condition of the lumen was obtained by roentgenographic and pathological examinations.

RESULTS

In all sixteen dogs were operated upon. Three died within twenty-four hours of operation from too sudden obstruction of the thoracic aorta. These animals are included because they represent one of the disadvantages of using fascia. With a pliable, plastic, substance such as tapes, ligatures or tissue strips it is difficult to judge the degree of constriction of the vessel. Pathological examination of these animals showed that insufficient opening had been left in the aorta for preservation of life. To overcome this disadvantage the fascia was pulled tight onto small rods which were removed after the tissue was fixed with sutures. But it was found that the character of the thrill distal to the obstruction was the best guide to the degree of obstruction. With rigid substances such as aluminum bands the amount of constriction can be judged more accurately.

In four of the sixteen animals rupture at the site of the constriction occurred. Three of these had the fascia applied to the thoracic aorta and one to the abdominal portion. The rupture occurred in one animal on the seventh postoperative day, in two on the tenth and in the one on which the abdominal aorta was used on the seventeenth day. A drawing of one of the specimens where rupture occurred on the tenth day after operation is shown in Figure 2. In two of the animals rupture occurred at the site of contact of a silk stitch with the vessel wall. Such a specimen is shown in Figure 3. This experience serves to illustrate the danger of allowing the arterial wall to be repeatedly thrust against an unyielding object like the knot

of a suture. But even where the vessel did not rupture its wall was weakened at the site of the constriction. A longitudinal section of the aortic wall after one month's pressure from a tissue band is shown in Figure 4. Here it will be seen that the expansile thrust with each pulse beat against the constricting device has caused atrophy of the vessel wall. The mechanism of rupture is evident.

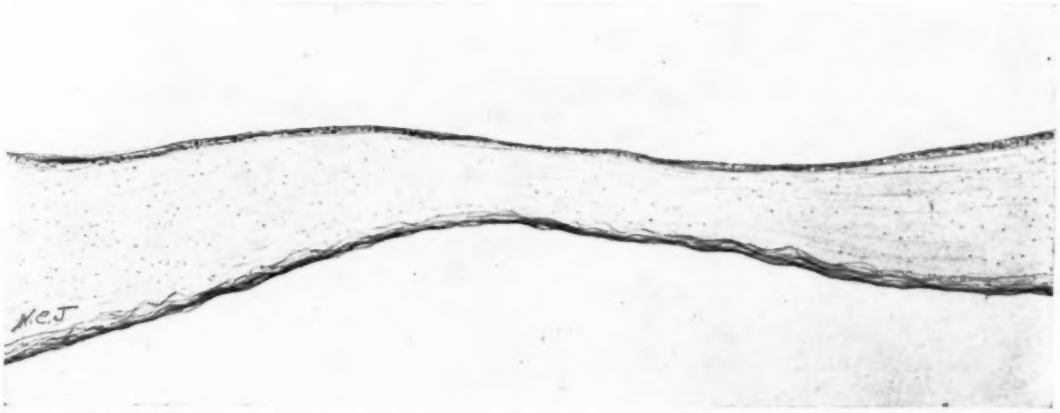


Fig. 4. Longitudinal section of aorta one month after application of a partially obstructing fascial band. Atrophy of wall is evident. Magnified twelve times.

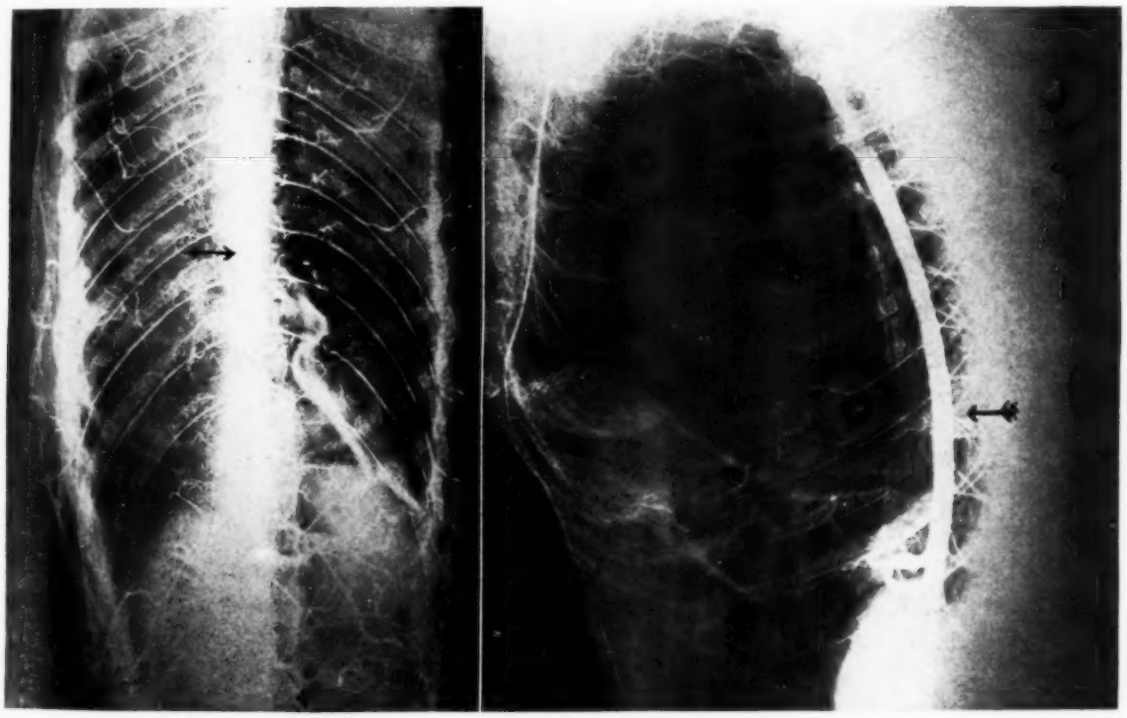


Fig. 5. Anteroposterior and lateral views of *x*-ray injection specimens of thoracic aorta three months after constriction with a tissue band. Lumen has completely reestablished.

Examination of the remaining nine animals revealed the following. In one month the fascia had partially relaxed. In two months it had usually completely relaxed though in some instances there was evident a slight amount of constriction. In three months it was always relaxed and partly resorbed. An *x*-ray injection of such a specimen is shown in Figure 5 where it will be seen that the lumen is reestab-

lished. In four months not only was the fascia relaxed but much of it had been resorbed. This condition is illustrated in

Fig. 6. Caliber of vessel has returned to normal and much of fascia has been absorbed four months after operation.

Figure 6. From these results it is seen that even when multiple turns of fascia are placed about a large artery restitution of the caliber of the vessel invariably occurs. Rather than having an increase in the constriction of the artery from fibrotic contracture there was resorption of the tissue band.

SUMMARY

1. A method of partial occlusion of arteries with six to eight turns of heavy fascia was attempted. This amount of connective tissue was used in the hope of inducing enough scar tissue contracture to complete the obstruction.

2. This method was used on the thoracic aorta of dogs in ten experiments and the abdominal portion below the renal vessels in six instances.

3. With a plastic substance such as tissue strips it is difficult to judge the degree of constriction. Because of this three animals were killed by too great obstruction of the thoracic aorta.

4. In four instances the arterial wall atrophied and ruptured at the site of the constricting device. Rupture occurred in from seven to seventeen days after operation.

5. In the remaining nine experiments relaxation of the fascia invariably occurred. Restitution of the caliber of the lumen was partial in one month and complete in from two to three months. Resorption of the tissue bands occurred in from three to four months.

6. The results of these experiments permit the conclusion that fascia is an unreliable and somewhat dangerous material to use for partial occlusion of the great vessels.

REFERENCES

1. Brooks, B. Ligation of the aorta. *J. A. M. A.*, 87: 722, 1926.
2. Halsted, W. S. The partial occlusion of blood vessels, especially of the abdominal aorta. *John Hopkins Hosp. Bull.*, 16: 346, 1905.
   Partial occlusion of the thoracic and abdominal aorta by bands of fresh aorta and of fascia lata. *Tr. Am. Surg. Ass.*, 31: 218, 1913.
   Partial, progressive and complete occlusion of the aorta and other large arteries in the dog by means of the metal band. *J. Exper. Med.*, 11: 375, 1909.
3. Hanford, J. M., and Wheeler, J. M. Pulsating exophthalmus. *Ann. Surg.*, 92: 8, 1930.
4. Hitzrot. Quoted from Wheeler, J. M. Pulsating exophthalmus. *Atlantic M. J.*, 31: 812, 1928.
5. Matas, R., and Allen, C. W. Conclusions drawn from an experimental investigation into the practicality of reducing the caliber of the thoracic aorta by a method of plication or infolding of its walls by means of a lateral parietal suture applied in one or more stages. *Tr. Am. Surg. Ass.*, 31: 196, 1913.
   Occlusion of large surgical arteries with removable metallic bands to test the efficiency of the collateral circulation. *J. A. M. A.*, 56: 253, 1911.
6. McNealy, R. W., and Lichtenstein, M. E. A study of arterial occlusion by means of autogenous fascial strips. *Surg. Gynec., Obst.*, 47: 99, 1928.

[For remainder of References see p. 252.]

THORACOPLASTIC SURGERY IN CHRONIC TUBERCULOSIS WITH ASSOCIATED EMPYEMA*

WILLIAM H. THEARLE, M.D.

LOS ANGELES, CALIF.

THE occurrence of empyema in the course of advanced pulmonary tuberculosis initiates a grave era with a hopeless outlook ordinarily, unless radical thoracoplastic procedures can be early instituted, which unfortunately are so often not feasible in this impoverished group of patients. The following case well illustrates the frail physical specimens that commonly confront us in this surgical field, and the extent of graded operative work that oftentimes becomes necessary to reclaim these relative derelicts:

E. Y., a thin anemic married woman, poorly developed, aged thirty-eight, claimed good previous health save for frequent colds for several years, and contact with a tuberculous brother. The onset of her tuberculosis dated back to May 1926, when she failed to weather one of her so-called colds. Temperature and productive cough persisted with increasing loss of weight and strength; she became hoarse and had pleuritic pains in left chest. A small hemorrhage soon occurred. Patient continued a downward course, and was admitted to County sanatorium in January, 1927, with advanced involvement of left lung and upper lobe cavitation, but contralateral lung was good except for some activity at the apex. She was in poor condition, quite toxic and the outlook was unfavorable under conservative regimen.

Artificial pneumothorax was wisely started without delay and satisfactory compression was soon obtained with resultant clinical improvement which slowly but steadily continued, and by the following summer the patient was markedly improved, sputum negative. She became semiambulatory in October with no cough or expectoration, had mostly regained strength and 6 lbs. in weight, and condition was good. Hemoglobin 75 per cent, R.B.C. 4,000,000, pulse 90, B.P. 120/78.

In November, 1927 she developed a small pleural effusion, which markedly increased by the end of the month, and aspiration became necessary to relieve the cardio-respiratory embarrassment incident to fluid. December found her running an irregular septic temperature with repeated aspirations necessary to keep down the serous tuberculous exudate; the following month revealed conditions becoming worse, temperature high, patient quite septic and the fluid became purulent.

In February, 1928, a low thoractomy was performed with evacuation of large quantity of thick foul pus, and tube was inserted for drainage. This resulted in a brief period of improvement, but the patient was seriously ill and toxic till late spring of this year, and required three blood transfusions to tide her over this period. The pleural cavity was irrigated with Dakin's solution for a while till the presence of a bronchial fistula became evident, after which bland solutions of aniline dyes, acriflavine, salt, etc. were used but with desultatory results. Pus was negative for tubercle bacilli repeatedly but showed various cocci and some gram-positive bacilli.

The patient improved during the summer and fall, the upper portion of the left lung had reexpanded and the empyema cavity was much smaller, holding little over 300 c.c.; there was drainage of 30 to 60 c.c. of thick pus daily. Toward the end of the year her condition was such that a three-stage thoracoplasty, extrapleural, was believed advisable; sedimentation rate 20, hemoglobin 65 per cent, W.B.C. 11,600, polymorphonuclears 79 per cent, pulse 100, B.P. 104/80.

Ribs 4 to 11 were resected posteriorly (4 inch segments) in two stages, January 22 and February 19, 1929 under nitrous oxide. The patient stood the operation well except that the pulse became quite weak and rapid after the second procedure. She seemed to be decidedly benefited for several months. Alpine light was applied to the side, and because the

* Read before the Los Angeles Surgical Society, October 9, 1931.

disease was quiescent in the lung and the cavity reduced in size (200 c.c. capacity), further surgery was postponed with the patient multiple small stages could be attempted according to her physical response, although she was far from a good risk. Her hemoglobin

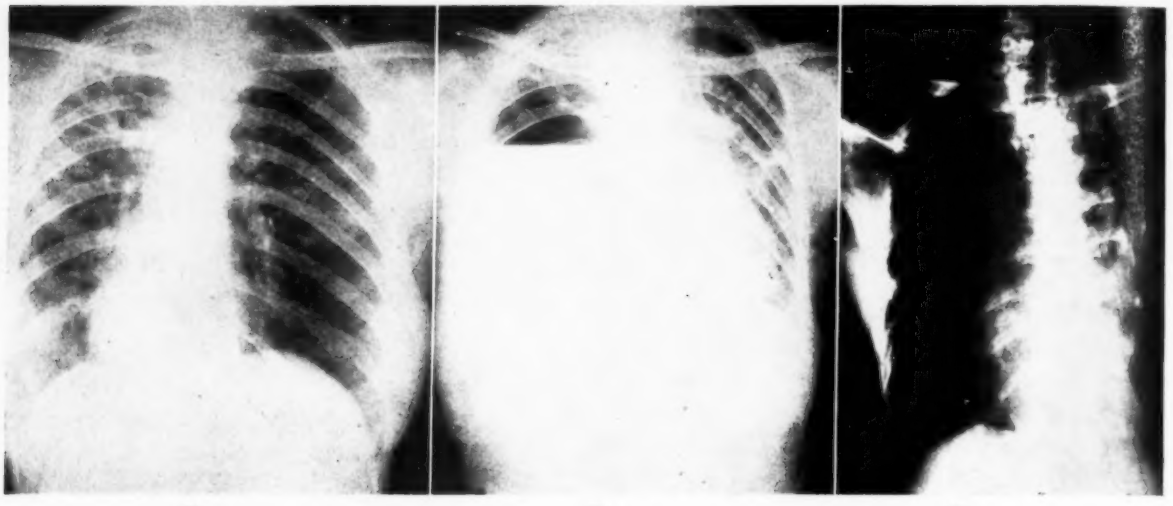


FIG. 1. FIG. 2. FIG. 3.

FIG. 1. Tuberculosis of left lung, Jan. 7, 1927.
FIG. 2. Left pyopneumothorax February, 1928, after one year of artificial pneumothorax.
FIG. 3. Extensive resection of left chest later necessary because of very thickened pleura and rigid chest wall (sequel to partial Sauerbruch thoracoplasty early in 1929).

better than for many months, and further improvement was expected in time. Pleural discharge increased late in the fall, and she had an occasional rise of temperature, and at the end of another year she had again lost some, when it was decided that additional collapse was necessary for the remaining pleural cavity and sepsis.

December 30, 1929 I first saw this patient in consultation relative to further thoracoplastic work, but did not consider this advisable unless she could be built up, her weakness and poor physical condition with considerable anemia and low cardiac reserve being the deterrents. Her hemoglobin was 55 per cent with 3,200,000 R.B.C., pulse 110–120, with B.P. 100/78 and she showed the effects of her prolonged toxemia; vital capacity 1150 and sedimentation rate 17. Discharge from empyema averaged 60 c.c. heavy pus. She was kept outdoors, placed on an anemic diet with large doses of Blaud's pills, and various non-irritating solutions were used in an effort to minimize her pleural absorption, but the return of cough because of the open bronchus soon interdicted all irrigations and topical medication was then used.

The latter part of April 1930 I was surprised to find that she had improved, so surgery in at this time was 62 per cent, sedimentation rate 21, pulse in the 90's and B.P. 104/60. On April 29, the upper three ribs were resected widely paravertebrally and also the regenerated segment of the fourth. Nitrous oxide anesthesia was used. Convalescence was uneventful save for several days with rapid pulse and vomiting.

On June 18 a parasternal resection of the second to sixth ribs (3 to 4 inches) was performed; intravenous sodium amytal was used at this stage as well as the next three, together with novocaine blocking of the intercostals. She stood this operation surprisingly well. The small sinus opening had become narrowed, as the cavity was now much smaller and drainage was inadequate, so on July 22 the sinus was laid widely open by removing scar tissue and thickened parietal pleura; the sinus extended downward ending blindly around the eleventh rib posteriorly, and also upward beneath the scapula to the sixth rib. The wound was left widely open. Except for pain and gastrointestinal upset, the patient suffered no ill effects from this procedure; suppuration soon diminished under visual medication but she did not improve through the hot weather, and in the middle of August she was given a transfusion to boost her strength and for her con-

tinued toxic anemia (hemoglobin 54 per cent which promptly increased to 70 per cent).

On October 7 and 28 the regenerated ends and axillary segments were resected (3 to 4 inches) of the seventh to eleventh ribs, and the empyema cavity was unroofed over this area by excision of ½ inch thick parietal pleura and adherent scar. The patient had a week of nausea and vomiting after the latter procedure, and her come-back at this time was quite slow, and early in December she was given another transfusion which benefited her decidedly. The bronchial fistula was still open at the apex of the cavity, but there was a scant amount of suppuration. Alpine lamp and heliotherapy (when practicable) were given into the cavity, which was packed with Bipp for a while without much improvement.

March 7, 1931 a posterior shelf overhanging cavity due to the posterior ends of fifth, sixth, and seventh ribs were resected (2 inches) with overlying pleura and scar. This procedure did not seem to set the patient back any. The pleural cavity began to look healthy towards the end of the month, was irrigated with a weak solution (1:1000) of bismuth-violet, and lightly packed with this dye in a 25 per cent alcoholic solution in strengths varying from 1:100 to 1:500. Cultures showed the cavity to be sterile by the middle of May, and as the patient was in a fair condition, a plastic closure was done under ethylene on May 27. An atrophied latissimus dorsi muscle was the only available structure to fill the remaining $4\frac{1}{2} \times 2 \times \frac{1}{2}$ inch cavity, and after superficial decortication of the visceral pleura a large pedicle of this muscle was freed to its attachment to the inferior angle of the scapule and implanted into the cavity and over the fistulous opening with chromic sutures, and overlying soft tissues were approximated with rubber tissue drains inserted down to the pleura. A small area was left at the inferior portion as the extreme thinness and scant musculature of this patient afforded little adjacent structures for an ideal plastic closure. It was hoped the overlying soft tissue would form a scar in this small space.

The patient is improving slowly but progressively; color is good, there is no cough or dyspnea, pulse 90, B.P. 106/78. Appetite is good; she is semiambulatory.

The small area has decreased in size, but cultures showed skin cocci during the summer; discharge was negligible. The area was sterilized with violet dye as previously, and as its obliteration by nature appeared rather remote (if ever) from the progress made since May, the first of last week it was closed by dissecting soft tissues well back, freshening its scarred walls, implanting a small section of scarred dorsalis spinae muscle into the area and approximating the adjacent soft tissues.

This woman has had a very stormy siege with multiple operations because of her markedly lowered physical condition, which safely permitted little surgery at any one sitting, and her early partial thoracoplasty, which had to be done over, with bony regenerations and scarred thoracic wall, made later operative work more difficult and shocking, and prolonged the period of surgical work quite materially.

The patient weighs 110 lbs. now; vital capacity is 950, pulse 80 to 90; she feels well and is improving. It is believed that another six months will find her markedly better and in surprisingly good condition in spite of her deformity and physical handicap.

NON-PARASITIC CYSTS OF THE SPLEEN

WITH REPORT OF A PATIENT SUCCESSFULLY OPERATED UPON*

BENJAMIN T. TILTON, M.D.

NEW YORK

CYSTS of the spleen are rare. Osler stated that he had seen only two in his own practice, one of which was an echinococcus cyst and the other a serous cyst of the hilus. Ziegler in his "Pathology" made no mention at all of splenic cysts. Novak classifies them as follows: (1) Dermoid cysts (extremely rare). Only 2 cases have been recorded. (2) Parasitic cysts (echinococcus). These are commonly associated with other similar cysts in other parts of the body. (3) Non-parasitic cysts: (a) traumatic; (b) inflammatory; (c) degenerative cysts; (d) dilatation cysts; (e) neoplastic cysts.

FIG. 1. Before operation showing displaced stomach.

FIG. 2. After operation showing stomach returned to its normal position.

Non-parasitic cysts only will be discussed in this article. While the literature is still scanty the number of cases reported by surgeons has increased considerably in the last decade, especially cases of large cysts which produce definite symptoms. Those of small size which cause no symptoms and are found either at autopsy or in the course of operations for other conditions within the abdomen, are of no clinical interest. The simplest classification of these non-parasitic cysts seems to me to be that of Calloust. He distinguishes the hematogenous or hemorrhagic cysts sometimes called pseudocysts and the true cysts which always have an endothelial lining. The former hold the chief interest for the surgeon as they are by far the more common and on account of their much larger size are the ones that produce clinical symptoms. These large cysts are always single and of regular outline. They have occurred more commonly in women and most frequently between the ages of twenty and fifty.

Etiologically these large non-parasitic cysts result from a hemorrhage caused by rupture of the capsule of the spleen and

* Submitted for publication September 17, 1931.

the formation of a hematoma which becomes encapsulated by the production of a fibrous envelope. They are therefore superficial to the spleen or perisplenic. The cause of the extracapsular hemorrhage and cyst formation is not always clear. Out of 17 cases collected by Bryan, there was a history of traumatism in 8, and of malaria in 7. It is possible that the tense capsule of an enlarged malarial spleen may give way causing hemorrhage followed by encapsulation. In the case that I am reporting there was no history either of traumatism or malaria. In the traumatic cases the history of injury may precede that of the appearance of the cyst by a long period. In Credé's case the interval was ten years.

The pathological examination of the cyst wall shows dense fibrous tissue with no endothelial lining. The cyst which is always unilocular contains a sanguineous or serosanguineous fluid with disintegrated blood cells and debris. The contents vary in amount from 2 to 8 liters. The cyst wall may become thick and adherent to surrounding structures, particularly the omentum, stomach and diaphragm. The symptoms of the type of cyst under consideration are variable, and not characteristic. There may be no symptoms whatever until the cyst has become of such a size as to produce pressure on or adhesions with adjacent structures. There may be local discomfort in the left hypochondrium, or actual pain local or radiating. *X*-ray may show a shadow in the left hypochondrium. A gastrointestinal series proved of great diagnostic value in my case as it showed marked displacement of the stomach downward and to the right, which pointed very strongly to pressure from an enlarged spleen or splenic tumor. Palpation may give a feeling of fluctuation.

The treatment is entirely surgical. Splenectomy is the operation of choice. Incision and drainage is an unsatisfactory method. It means a prolonged or even permanent fistula followed by possible secondary operation. Excision of the cyst is necessarily associated with considerable hemorrhage and is hence more dangerous than splenectomy. In the absence of dense

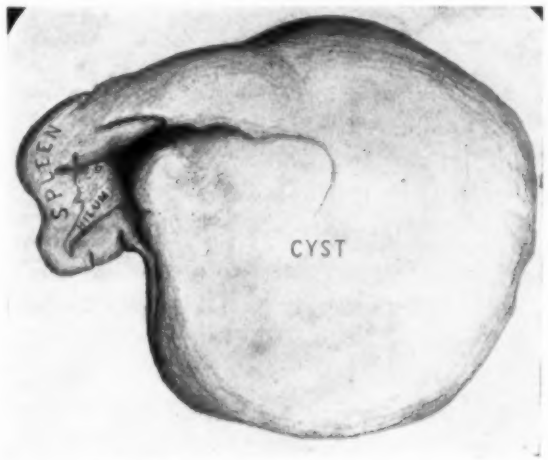


FIG. 3. Specimen after splenectomy.

adhesions the latter operation should offer no technical difficulties.

The following case of a patient referred by Dr. Joseph J. Berkowitz was admitted to the hospital December 5, 1928.

Female, twenty, occupation, bookkeeper. *Family history* negative. *Past history* negative except for the usual diseases of childhood. No history of malaria or traumatism.

Present History. Four years ago a swelling appeared in the upper part of the abdomen which grew gradually in size. For the past month she has had a feeling of pressure in the abdomen.

Physical Examination. Heart, lungs, and blood pressure normal. Examination of the abdomen shows the presence of a large mass in the epigastrium more marked on the left side, causing bulging of the left costal margin and extending downward to within 2 in. of the umbilicus. The mass is smooth and slightly tender. It moves with respiration and gives a sense of crepitation on palpation.

Laboratory Findings.

Urine negative
Hemoglobin 75 per cent
Red blood corpuscles 4,550,000
White blood corpuscles 8,720
Wassermann test negative.

X-ray. A gastrointestinal series revealed a normal stomach located in the right lower

quadrant with the duodenum in the normal position. The abnormal location of the stomach is apparently caused by pressure by the mass in the epigastrium.

The preoperative diagnosis was cyst of the spleen, probably echinococcus.

Operation revealed a large cyst attached to the spleen. The spleen itself was moderately enlarged. The cyst was thick walled and adherent to the diaphragm. Splenectomy was performed without special difficulties and the postoperative course was without incident.

Laboratory Findings. The cyst was intimately connected with the spleen and contained about 6 liters of thick chocolate colored fluid.

Microscopically the cyst contents consisted of degenerated blood and debris. There was no endothelium in the inner lining of the cyst wall.

X-ray taken several weeks later showed the stomach in a normal position.

The patient continues to be well after three years and has suffered no disturbances from the loss of her spleen.

REFERENCES

1. Bryan, W. A. Cysts of the spleen, *J. A. M. A.*, 45: 680, 1905.
2. Fowler, R. H. Non-parasitic cysts of the spleen. *Surg. Gynec. Obst.*, 11: 133, 1910.
3. Calloust. Kystes hematogenes de la rate. Paris. Ollier-Hening, 1913. P. 118.
4. Novak, E. Large single cysts of spleen. *Surg., Gynec. Obst.*, 45: 586, 1927.
5. Frank. *Ann. Surg.*, 85: 360, 1927.

REFERENCES OF DR. PEARSE*

7. Nassetti, F. Quoted from Halsted. Avvolgimento di vasi Sanguigni con lembi liberi di aponeurosi. *Atti della R. Acad. dei Fisiocritici in Siena*, April 26, 1912.
8. Neff, J. M. A method for gradual automatic occlusion of the large blood vessels at one operation. *J. A. M. A.*, 57: 700, 1911.
9. Pearse, H. E. A method for the gradual occlusion of the aorta. *Surg. Gynec. Obst.*, 46: 411, 1928.
10. Reid, M. R. Partial occlusion of the aorta with silk sutures and complete occlusion with fascial plugs; the effect of ligatures on the arterial wall. *J. Exper. Med.*, 40: 293, 1924.
11. Sheffelaar-Klots, T. The use of fascia lata for the occlusion of arteries in case of aneurysm. *Ann. Surg.*, 93: 635, 1931.

Note after correcting proof: Publications of James L. Campbell have been omitted. Six cases of partial occlusion of the common carotid are reported with clinical improvement. *Southern M. J.*, 19: 795, 1926; 21: 539, 1928.

*Continued from p. 246.

GENERAL PRINCIPLES IN THE DIAGNOSIS OF INJURIES OF THE LOWER BACK & PELVIS*

JAMES M. TROUTT, M.D., F.A.C.S.

HOT SPRINGS NATIONAL PARK, ARK.

INTRODUCTION

THE effect of trauma in the region of the lower back and pelvis seldom results in a solitary lesion of the muscular or bony framework. Injury to the protecting and supporting structures is frequently associated with damage to viscera contained in the bony pelvis, and neural apparatus in the spinal canal. These latter complications are of far-reaching effect, and generally overshadow in importance the primary lesion.

The effects of trauma cover a wide range; but it is precisely these contingencies which the orthopedic surgeon must be prepared to differentiate when he is confronted with a patient exhibiting pain in the lower back, walking, sitting, or standing disability, muscle spasm, and the local signs of injury in this region. A case may show but few or minor symptoms at first and appear to be of trivial import, and within a few hours progress to a serious cord lesion. On the other hand, the presence of severe shock, inability to void or incontinence, and obvious deformity, while significant, is not incompatible with complete recovery.

The scale of severity of back and pelvic injuries runs through the octaves of muscular strains, railway spines, subluxations, dislocations, fractures, gunshot and stab wounds, and the various combinations and complications of these.

CORRELATION OF INJURIES

The erect posture of man, locomotion, and the majority of the purposeful motions of the lower extremities are dependent upon the integrity of the pelvic ring and maintenance of the line of gravity in certain planes. Because of this interrelationship, impairment of a part affects the whole, and minor derangements are often productive of symptoms out of proportion to, or seemingly independent of the original trauma.

Consequently, a discussion of muscular strain of the back involves a consideration of fracture of the transverse processes of the lumbar vertebrae. Moorhead[11] states that dislocation of the dorsal and lumbar spine without fracture is rare; he quotes Keen to the effect that, "experimentally, dislocation, (without fracture), cannot be produced below the fifth dorsal spine." Frazier[6] estimates that of 100 injuries of the spinal column, 60 will be fracture-dislocations, 20, fractures, and 20, dislocations.

The lower dorsal and lumbar region is preeminently the location of fracture-dislocation. The potentiality of cord damage in the latter lesion is obvious; the cord may be contused, compressed, lacerated, or completely severed. Again, it is embarrassing at times to find that a fracture may unite with a good anatomical result, but through many related factors leave a static defect that is almost as disabling as the original injury.

Wilson and Cochrane[14] classify sacroiliac luxation as a variant of fracture of the posterior border of the ilium; and separation of the pubic symphysis as a variant of fracture of the pubic bones. In the latter case, if the bone is stronger than the ligaments, the articulation opens out. This cannot occur without injury or at least sprain of the sacroiliac joint.

Colp and Findlay[3] found in a small series of 35 cases, that 17 per cent of

* Submitted for publication July 24, 1931.

patients having fractures of the pelvis were unable to void afterwards, but only 8 + per cent had actual bladder injury.

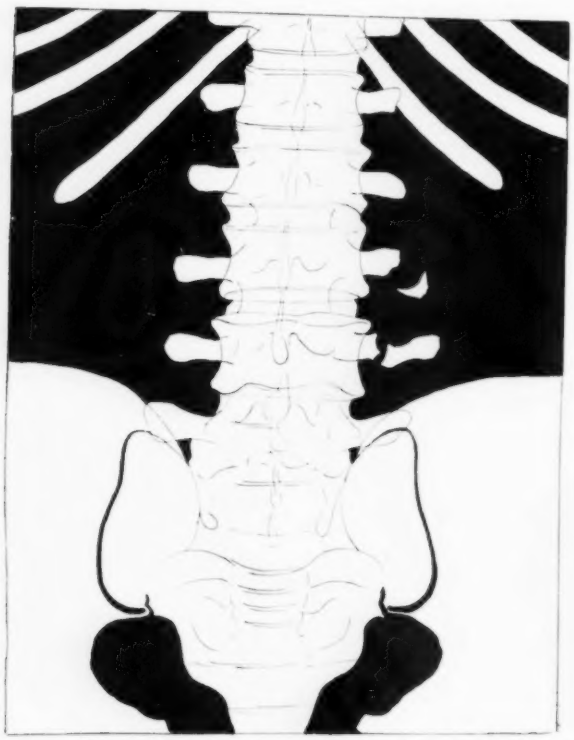


FIG. 1. Sketch from skiagraph showing fracture of transverse processes of fourth and fifth lumbar vertebrae, left.

S., Samuel, white farmer, aged thirty, received injury to back in fall from hay-loft. Did not result in any marked degree of disability and patient applied home remedies for a sprained back. Nature of injury was discovered several months later incident to routine examination for compensation as a World War veteran. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

They conclude that not all pelvic fractures involve injury of the genitourinary tract, but that 50 per cent of ruptured bladders occur with fractured pelves. McWhorter[10] quoted Keyes to the effect that tears of the posterior urethra resulted only from a fracture, dislocation, or strain on the pelvis. Campbell's[2] figures approach these also: in 20 of 55 cases of ruptured bladder, there were associated pelvic fractures.

In 166 fractures of the pelvis in Bellevue Hospital from January 1919 to January 1928, 15 per cent, or 1 in 7, had vesical rupture. In 3 others, rupture of the posterior urethra had occurred. Furthermore, in many cases of fracture without demonstrable vesical rupture, distressing urinary symptoms were present

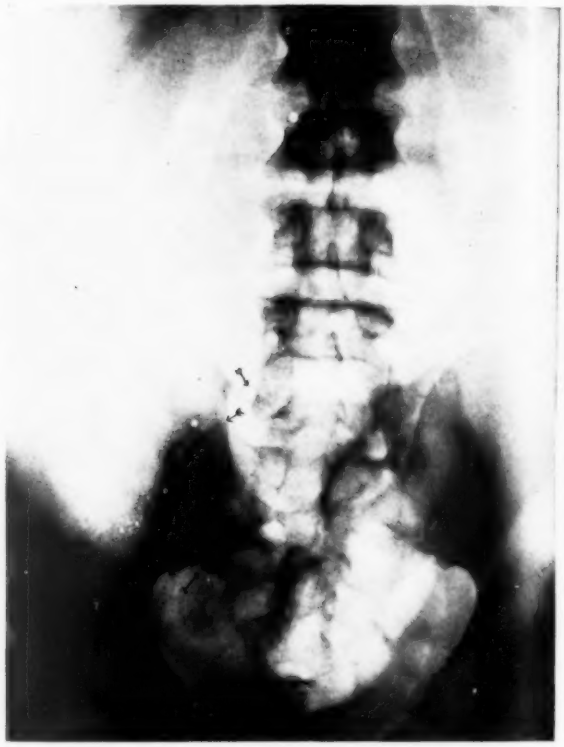


FIG. 2. Print from skiagraph demonstrating fracture of right inferior articular process of fifth lumbar vertebra and right sacroiliac dislocation.

H., Paul, Sgt. Q.M.C., white soldier, aged thirty-one, thrown from truck, landing on his back heavily on frozen ground, and in addition to above, sustained fractures of ninth and tenth ribs, right. Soldier had extreme disability at first but returned to duty in six weeks and has had no recurrence of symptoms to date. Recent skiagraphs reveal no change in sacroiliac joints. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

as follows: acute retention 32, marked dysuria 5, and gross hematuria 36.

DEFINITION OF TERMS

The nosology of pelvic and low back injuries would be much clarified if there were less ambiguity displayed in their nomenclature. Fortunately, this region seems to have escaped the blight of eponyms; Kümmell's disease is unique, and even its legitimacy is doubtful.

Acceptance of the entity of sacroiliac, lumbosacral, and pubic symphysis sprains,

subluxations, dislocations, or separations implies that they are joints of the amphiarthroidal order at least. A priori, reference

Fig. 3. Print from skiagraph illustrating doubtful fracture at posterior and inferior border of body of second lumbar vertebra, left side.

B., Earl, white soldier, aged twenty-three, admitted by transfer from another hospital nine months after back injury received by being thrown from horse at mounted drill. Original diagnosis was fracture of body of second lumbar vertebra at its anterior and left lateral lip. At that time sacralization of transverse process of fifth lumbar vertebra, right, was also diagnosed. Skiagraphs made nine months after injury do not confirm diagnosis of fracture, but do show a peculiar defect at posterior inferior border of body of second lumbar vertebra, left side. (*Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.*)

to these joints as synchondroses is inconsistent. Spondylolisthesis is a purely descriptive term, indecisive as to exact location, and should be discarded for lumbosacral subluxation or dislocation.

The use of the words strain and sprain interchangeably is not consonant with their etymological derivation. To strain, means to overuse; to overexercise. Kinetic energy is a property of muscle in contradistinction to the passivity of joint motion not initiated or controlled by muscle. Clearly, then, the term strain should be restricted to injury of muscle tissue. This is all the more justified by the definition of sprain, which is explicit in its application; it is the

Fig. 4. Reproduction from skiagraph showing sacralization of transverse process of fifth lumbar vertebra, right, with formation of false joint.

Same patient described in Figure 3; patient's back creaked on motion, and he complained of a variety of symptoms, majority of which were subjective. Sacralization is believed to account for fact that he left hospital only slightly improved. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

wrenching of a joint, with partial or complete injury of its attachments without luxation of bones.

Low back pain has been frequently ascribed to relaxation of the sacroiliac joints, whatever that may mean. Undoubtedly this terminology originated with the prevalent belief that during pregnancy there is a general relaxation of all the pelvic ligaments which allows to some extent at least, a definite increase in the diameters of the parturient canal. This ligamentous relaxation is a purely physiological process, and usage of the word to describe a traumatism is objectionable.

One writer speaks of diastasis of the vertebrae, apposite to a condition in which the vertebrae are separated from each

other in their vertical axes but without disturbance of the plane of the articular surfaces to each other. Without prejudice to this author's experience, I should say it does seem that this is just another superfluous name for a sprain of the vertebral joints involved.

There is some justification for the usage of the term separation as applicable to dislocation of the symphysis pubis. This joint enjoys very limited motion in a single plane, which results in a deviation of the pubic bones from one another in a horizontal direction.

Standardization of nomenclature of dislocations in the direction of simplicity is most desirable. Sprain, subluxation, and dislocation, in order, are amply descriptive of the degrees of derangement.

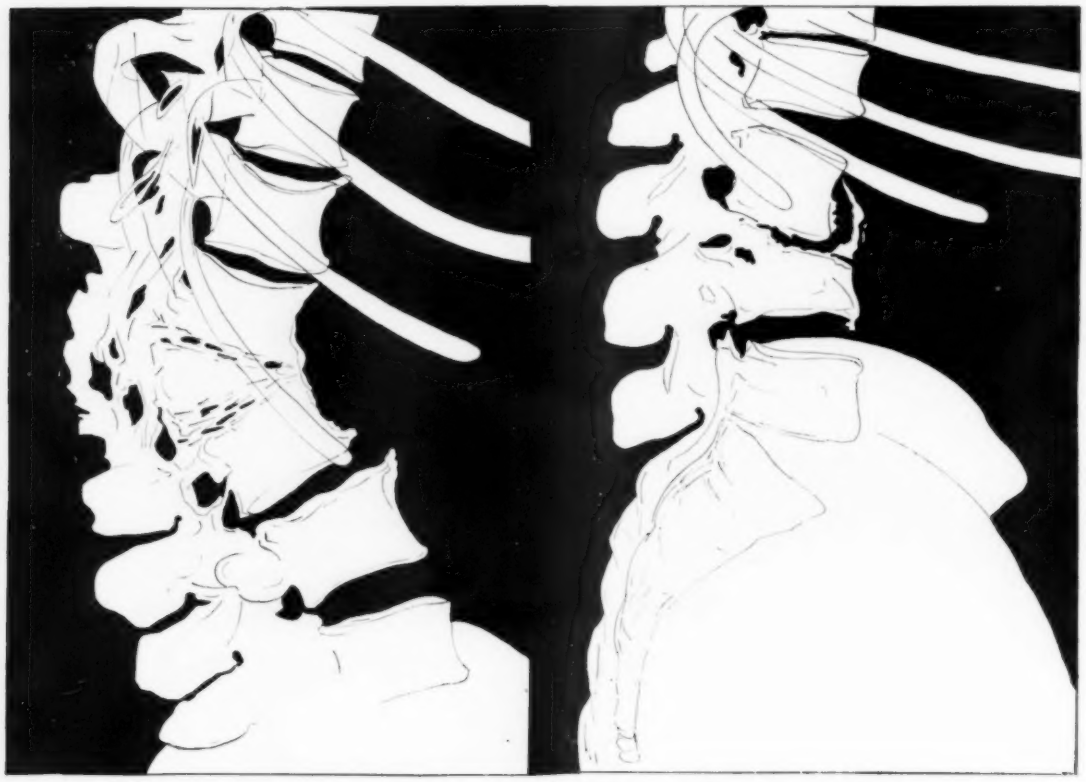


FIG. 5. Sketch from skiagraph showing fracture of second lumbar vertebra which has healed with deformity but no symptoms.

P., William, white, ex-soldier, aged fifty-two received crushing injury of back in automobile wreck. There was jack-knife bending of back; no visceral symptoms, and patient returned to his occupation of day laborer in three months from date of injury. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

FIG. 6. Sketch from skiagraph illustrating compression, destruction, and almost complete absorption of body of third lumbar vertebra and partial absorption of fourth lumbar.

S., Oscar, colored ex-soldier, aged forty-three, admitted to this hospital for treatment of old osteomyelitis of greater trochanter of right femur, with chronic discharging sinus. Disease dated from injuries sustained twelve years previously, when engaged as a laborer, helping at housemoving. While placing supports under one corner of a house, it fell, compressing his lower back and right hip. Patient had transient visceral symptoms and long-continued disability following injury. Now able to walk without limp and do manual labor. Appearance is extremely suggestive of quiescent Pott's disease of spine rather than fracture. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

CLASSIFICATION OF INJURIES

Traumatisms of the lower back and pelvis, without reference to surface wounds, permit of the following anatomical classification:

- I. Muscle
  - 1. Contusion
  - 2. Strain
  - 3. Fibrositis
  - 4. Myositis ossificans
- II. Joint
  - 1. Sprain
  - 2. Subluxation
  - 3. Dislocation or separation
- III. Bone
  - 1. Static defect
    - a. Alteration of weight-bearing line from any cause
    - b. Spinal curvature
  - 2. Fracture
- IV. Gunshot and stab wounds
- V. Associated visceral injury
  - 1. Spinal cord
  - 2. Genitourinary system
  - 3. Nerves and blood vessels
  - 4. Bowel

ANATOMICAL DISCUSSION

The more important muscles which may be involved in traumatisms of the lower back include the latissimus dorsi, the erector spinae, the fifth layer of short muscles of the back, of which the interspinous and the intertransverse are examples, the quadratus lumborum, and the iliopsoas. The musculature of the back extends in almost unbroken continuity from the sacrum to the occiput. It has an enormous capacity for leverage on the trunk and lower extremity. Also the gap between the ribs and the pelvis is bridged by muscle alone. These circumstances are ample explanation of the frequency of muscular strains and of avulsion fractures, when muscle function is perverted.

Best[1] thinks that the most frequent and major cause of low back pain is a traumatic myositis of the sacrospinalis and gluteal muscles. The possibility of a muscular fibrositis and even of myositis ossificans, in this connection, cannot be denied.

The spine supports the cranium, and is the connecting link between it and the pelvis. It provides a durable and stable but flexible container for the spinal cord, insuring neural continuity from the cerebrum and higher centers to the periphery. The following verbatim quotation from Gray's[7] "Anatomy" is classic.

> The construction of the spinal column, of a number of pieces, securely connected together and enjoying only a slight range of movement between any two individual pieces, though permitting of a very considerable range of movement, as a whole, allows a sufficient degree of mobility without any material diminution of strength. The main joints of which the spine is composed, together with the very varied movements to which it is subjected, render it liable to sprains, which may complicate other injuries or may exist alone; but so closely are the individual vertebrae articulated that these sprains are

Fig. 7. Print from skiagraph showing multiple fractures of right pelvis with subluxation of right sacroiliac joint. W., James, white soldier, aged twenty-six, received multiple injuries in motorcycle crash, more important of which were fractures of right os pubis and ischium and rupture of urinary bladder. Extraperitoneal rupture of bladder was revealed by exploratory operation; there was about 800 c.c. of urinein space of Retzius; there was a severe y-shaped tear of right lateral wall of bladder; longest limb of tear extended from near vault on right, downward and forward, 12 cm., to base. Short limbs of y were about 5 cm. long. Wound in bladder was repaired, and drainage instituted suprapubically and also by indwelling urethral catheter. Soldier returned to duty in ninety days.

(1) Fracture line in horizontal ramus of os pubis. (2) Fracture in body of os pubis, internal to pubic spine. (3) Fracture in ascending ramus of ischium. (4) Subluxation of right sacroiliac joint. (Surg. Serv., Tripler U. S. Army Gen. Hosp., Honolulu, T. H.)

seldom severe, and an amount of violence sufficiently great to produce tearing of the ligaments would tend to cause a dislocation or fracture. The further safety of the column and its less liability to injury is provided for by its disposition in curves instead of in one straight line. For it is an elastic column, and must first bend before it breaks; under these circumstances, being made up of three curves, it represents three columns, and greater force is required to produce bending of a short column than of a longer one that is equal to it in breadth and material. Again the safety of the column is provided for by the interposition of the intervertebral disks between the bodies of the vertebrae, which act as admirable buffers in counteracting the effects of violent jars or shocks. Fracture-dislocation of the vertebral column may be caused by direct or indirect violence, or by a combination of the two, as when a person falling from a height strikes against some prominence and is doubled over it. The fractures from indirect violence are the more common, and here the bodies of the vertebrae are compressed, while the arches are torn asunder; while in fractures from direct violence, the arches are compressed

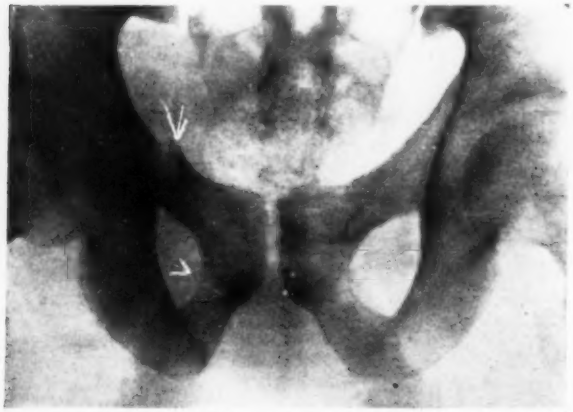


FIG. 8. Print from skiagraph showing fracture of both rami of right pubis. T., Everett R., white soldier, aged twenty-five, incurred above injury in automobile wreck; was thrown clear from car striking right side of pelvis against tree. No complications and soldier returned to duty in forty-five days. (Surg. Serv., Tripler U. S. Army Gen. Hosp., Honolulu, T. H.)

FIG. 9. Print from skiagraph showing multiple fractures of pelvis with much deformity. B., James L., a white ex-soldier, aged thirty-five, incurred multiple fractures of pelvis and rupture of bladder in an automobile wreck; there were double fractures of horizontal rami of pubis and ascending rami of ischium. Disability was immediate and complete. Displacement of fragments was more than usual. Bladder was repaired successfully and patient made a slow and stormy recovery. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

FIG. 10. Print from skiagraph of same case shown in Figure 9, taken four months after injury. Union has occurred, but is probably fibrous. Patient was discharged after ten months hospitalization, able to walk and do light work. At time of discharge his greatest complaint was inability to find a comfortable sitting position and inability to rise or sit down smoothly and quickly. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

and the bodies of the vertebrae separated from each other. It will therefore be seen that in both classes of injury the spinal cord is the

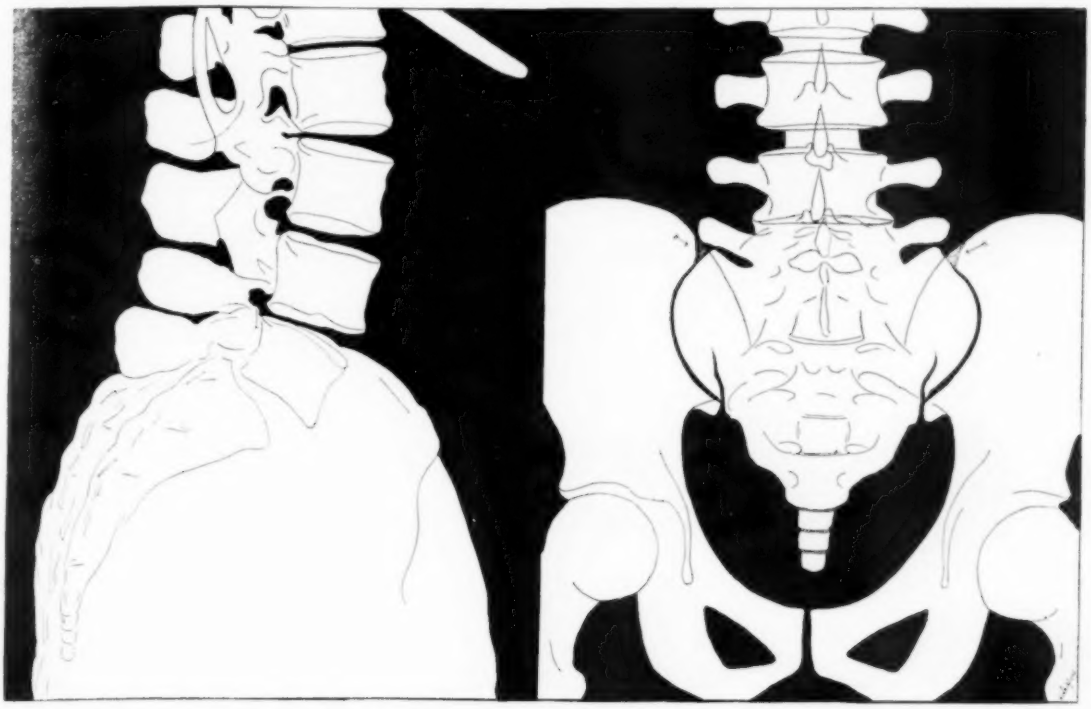


Fig. 11. Sketch from skiagraph showing lumbosacral dislocation (spondylolisthesis). R., Waldo A., white ex-officer U. S. Army, aged forty-six, sustained multiple injuries and wounds in action during the World War, including aeroplane crash. Symptoms of irritation of peripheral branches of lumbar plexus prominent on admission, and ascribed by patient to fall on back incurred in 1919. Patient left hospital but slightly improved by physiotherapy and other accepted methods of treatment. Did not take advantage of operative fusion of lumbosacral joint. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

Fig. 12. Sketch from skiagraph of anteroposterior view of same patient shown in Figure 11, illustrating rotation of sacrum in lumbosacral dislocation. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

part least likely to be injured, and may escape damage even when there has been a considerable lesion of the bony framework.

The pelvis is built to *stand under*, to *sit on*, to *hang to*, and to *cover in*. It must have strength and elasticity to bear constant loads under varying conditions. It absorbs shocks from above and below. The individual units of the pelvis, the ossa innominata and sacrum which includes the coccyx, are tied together by joints which have a very small range of motion but an extensive capacity for distributing stresses and strains. The value of the lumbosacral and sacroiliac joints, as well as the symphysis pubis, lies not in the motion they furnish, but in the expansion and contraction of the pelvic ring as a unit which their structure and strategic location permits.

With but little stretch of the imagination one can visualize the pelvis as composed of a series of four trusses, one anterior and one posterior on each side. These trusses close in the pelvis with angles apposed at the acetabula, the anterior trusses being situated in a lower plane than the posterior.

The two posterior trusses, represented by the ilia, are tied together at their bases by the mortised-in sacrum as a tie-beam; the apices fuse laterally with the superior angle and part of the base of the anterior trusses to form the acetabula, which serves as a tie-rod to insure resistance to upward and lateral compression. A portion of the base of the anterior trusses forms the

ischial and pubic segments of the acetabulum; a little more than two-fifths by the ischium and one-fifth by the pubis. The

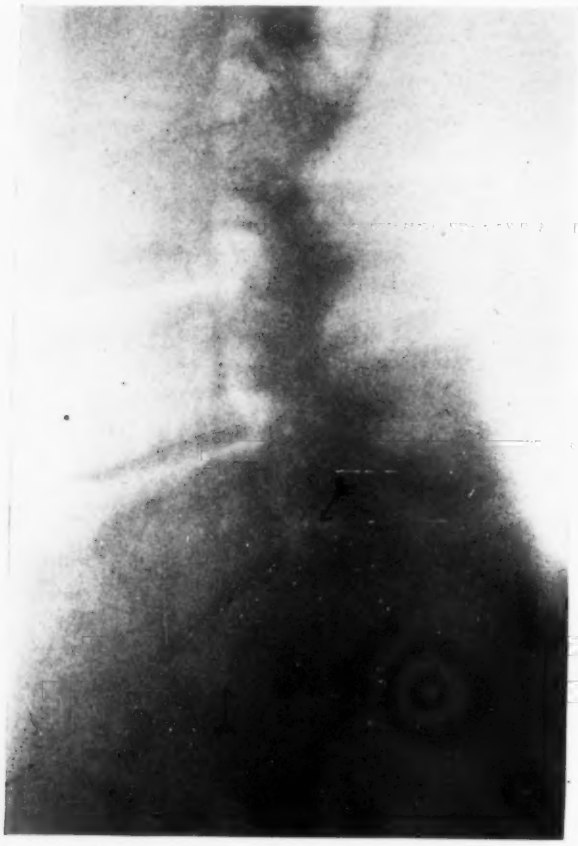


FIG. 13. Print from skiagraph; lateral view of same patient shown in Figures 11 and 12; giving more detail of lumbosacral dislocation. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

inferior angle of the base of these trusses and the remainder of the base form the ischial tuberosity, and carry the sitting weight of the body. The flattened apices come together anteriorly to form the symphysis pubis.

The pelvis is admirably suited to withstand downward, upward, and lateral compression, and is least able to endure force applied in the saggital direction. Wilson and Cochrane[14] enumerate five weak points; the two sacroiliac joints or the area just external to the joints, the symphysis pubis, and a point midway between the symphysis and the acetabulum on each side. Fractures of the pelvis are most common at these points.

ELEMENTS OF DIAGNOSIS

The first prerequisite in diagnosis is to establish the fact of a recent trauma which

FIG. 14. Print from skiagraph: anteroposterior view of same patient shown in Figures 11, 12, and 13. Rotation of sacrum is well shown. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

is adequate in degree and in proper relation to the symptoms present.

The importance of a careful, complete, and pertinent history cannot be overestimated. A history may seem superfluous in the presence of self-evident injury, but the existence of symptoms previous to the injury frequently has great bearing on the subsequent development of the case. The chronological appearance of the symptoms, their progression, and the appearance of contemporary signs is of the utmost value, particularly in the definition of spinal cord involvement and its extent.

It is amazing how many things may be responsible for backache and more or less disability but which are totally unrelated to trauma. It is not unusual for the symptoms to be described as having commenced about the time of an injury which is generally too trivial to have been effective. This is not to say that these are all instances

of neurasthenia, hysteria, or hystero-neurosis. Low back pain is commonly met with in visceroptosis, floating kidney, arthritis, neuritis, intercostal neuralgia, lumbago, sciatica, spinal cord lesions, chronic uterine, pelvic, and abdominal disease, static defects, spinal asymmetry, atypical vertebrae, and other developmental defects.

From such a welter of varied and vague paternity, the protagonists of sacroiliac relaxation, have resurrected it, as a common cause of low back pain.

PHYSICAL INVENTORY

A meticulous physical examination will usually reveal signs indicative of injury to a particular structure; rectal and vaginal examination should not be overlooked as they will permit palpation of nearly all the pelvic bones including the inner surface of the acetabulum. Tenderness on pressure, swelling, ecchymosis or discoloration, muscle spasm, restriction of motion, and pain on active or passive motion, are present in greater or less degree according to the severity of the injury. If deformity and preternatural mobility are present, together with these symptoms, fracture is almost certain, though fracture-dislocation is overwhelmingly the most common variety of fracture in the lower spine. Crepitus is rarely elicited in fractures of the spine and pelvis.

Prompt recognition of complicating visceral injury is the paramount consideration of diagnosis. Paraplegia, or lesser degrees of motor failure, sensory loss, disturbed reflexes, and interference with bladder and rectal function are evidence of cord involvement; inability to void, difficult and bloody urination, and bleeding from the urethra are suggestive of bladder damage. Perineal extravasation is a late development, but is pathognomonic of ruptured bladder. Hematomata and signs of circulatory weakness point to laceration of an important blood vessel. In addition to these, the symptoms of shock are present in greater or less degree determined by the gravity of the complication.

RADIOGRAPHY

The roentgen-ray is the final arbiter of the diagnosis in many cases of fractures and dislocations of the lower spine and pelvis. The development of the *x*-ray has been productive of great advance in diagnostic methods in this field particularly. It has demonstrated the occurrence of many lesions formerly unsuspected, specifically, fractured lumbar transverse processes. This lesion was not recognized prior to 1908. Conversely, the *x*-ray has great negative value, and has served to exclude certain purely functional conditions, such as concussion of the spinal cord, the euphemistic "railway spine."

Fig. 15. Print from skiagraph showing dislocation of left sacroiliac joint. O., Maryan, white soldier, aged thirty-two, was received at this hospital by transfer from another hospital for treatment of severe left-sided sciatica. Symptoms dated from severe back strain incurred five months previously while cranking heavy truck. Soldier returned to duty nine months after original injury, however, without complete relief of symptoms. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

It must not be forgotten also, that the *x*-ray has positive value in this field only in relation to the bony structures. Proper

regard must be had for the limitations of skiagraphs in the way of distortion. Pictures should be made in at least three

Fig. 16. Print from skiagraph of same patient shown in Figure 15. Static defect of scoliosis, left, of lumbar spine, secondary to primary injury. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

planes to obtain complete information: the anteroposterior, lateral, and oblique. Views of delimited areas give the sharpest detail. Consequently stereographic films are essential in most instances. The gross anatomical structure of the spine and pelvis is complex; shadows of the various portions occupy different planes, yet they are depicted upon the single plane of a skiagraph. To differentiate the shadows of the various components, they must be viewed stereographically.

Accuracy in diagnosis not only implies correct technique but requires great discretion in interpreting the findings. The latter comes only with experience; Pancoast[12] sounds a warning in the following words:

Fig. 17. Print from skiagraph interpreted as being essentially normal. E., Edward, white ex-soldier, aged thirty-eight, complained of great pain and disability referred to region of both sacroiliac joints; symptoms were said to have been of eleven years' duration without progression. In all other respects, physical examination of patient was negative for demonstrable pathology. Diagnoses had been made in other hospitals of arthritis of spine, sciatica, and relaxation of sacroiliac joints. Latter seemed to be most acceptable to patient: he was discharged as improved. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

Extreme caution must be exercised in interpreting the appearance of joint spaces for narrowing or widening as indicative of trauma or inflammation, as the spaces vary greatly in different individuals and in different joints in the same individual. Also the effect of variations in the angles of the joints may be very misleading. [With particular reference to the sacroiliac joints the same observer states]: It is useless to try and interpret slight

displacements of the sacroiliac joints without stereoscopic films. The width of the space depends on the thickness of the articular cartilages, which decreases with age. Relaxation can't be determined unless there be some displacement.

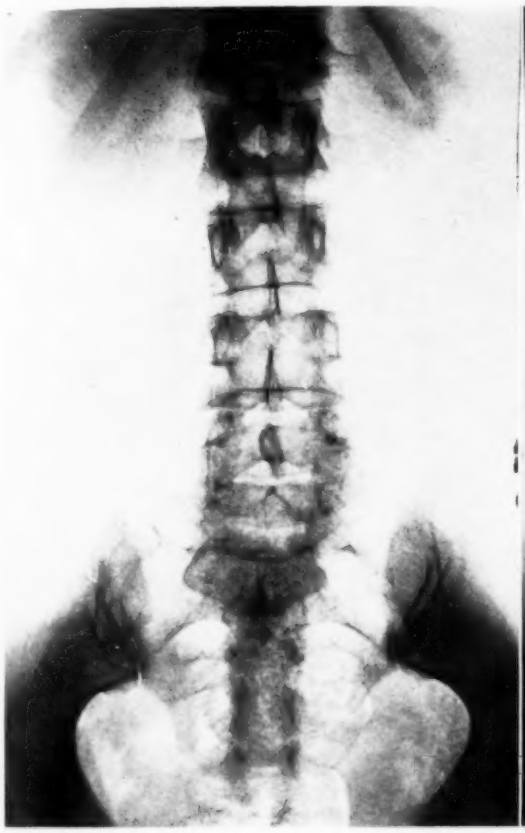


FIG. 18. Print from skiagraph showing anomaly of six lumbar vertebrae. Z., James, white ex-soldier, age not known; symptoms complained of were rheumatism of back. Patient was skiagraphed during course of examination for claim for compensation as a World War veteran. He was not hospitalized. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

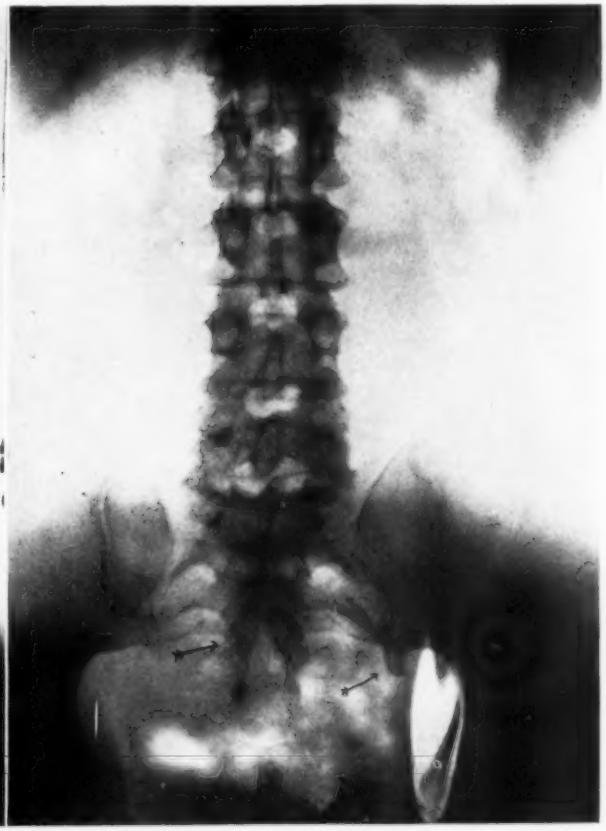


FIG. 19. Print from skiagraph showing a peculiar teat like process at lower angle of left sacroiliac joint, and also a patent sacral canal as high as third sacral segment. P., William, white ex-soldier, aged forty-four, under treatment for cerebrospinal syphilis. These anomalies were without significance in so far as symptoms were concerned. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

STRUCTURAL ABNORMALITIES

The connection of structural abnormalities or inequalities with low back pain is not clear, though the weight attached to their presence is being more and more discounted. Jones and Lovett[9] state that in 70 skeletons measured by Garson, the lower limbs were the same length in only 10. Morton measured 513 normal boys, and found that 292 presented an inequality in the lower limbs varying from ⅛ to 1⅝ in. Best[1] believes that little emphasis should be placed on spinal anomalies and abnormal outlines observed radiographically. He mentions Osgood's finding that 50 per cent of the plates taken at the Massachusetts General Hospital for various troubles did not show normal outlines of the back region.

It is a common observation that extra vertebrae, sacralized lumbar vertebrae, and even spina bifida, are frequently discovered in patients who are without symptoms and unaware of the existence of any abnormality.

The relation of low back pain to injury of the sacroiliac and lumbosacral joints has been productive of the most acrimonious discussion and contention. Sacroiliac

FIG. 20.

FIG. 21.

FIG. 22.

FIG. 23.

For legends see page 265.

dislocation has a literature all its own, since Goldthwaite first reported 500 cases in 1905. Diverse opinions are expressed by men of undoubted experience. One of the writers of Jones and Lovett's "Orthopedic Surgery" is quoted as never having seen a case of sacroiliac relaxation, subluxation, or separation. Forrester[5] doubts the existence of sacroiliac strain, and says Sir Robert Jones agrees with him.

All textbook authorities describe different degrees of sacroiliac derangement resulting from trauma, but few mention lumbosacral dislocation. Whitman,[13] perhaps, gives the most clear description of this condition, and uses the term spondylolisthesis. He states, however, that the lesion may originate independently of trauma from debilitated states and disease.

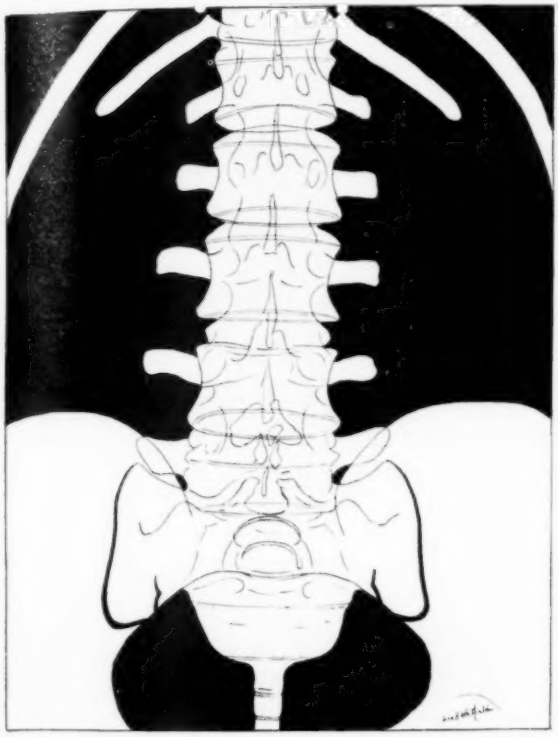


Fig. 24. Sketch from skiagraph; anteroposterior view of same patient shown in Figures 22 and 23, accentuating defects mentioned above. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

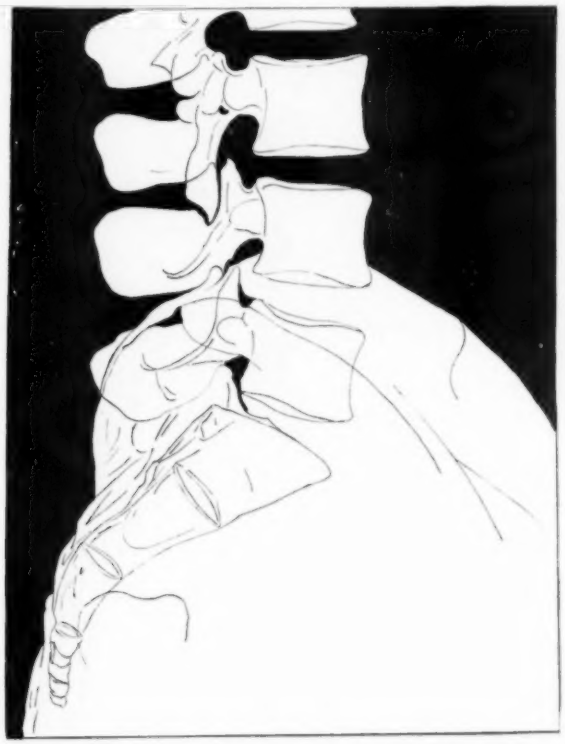


Fig. 25. Sketch from skiagraph; lateral view of same patient shown in Figures 22, 23, and 24, accentuating defects mentioned above. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

Fig. 20. Print from skiagraph showing female type of pelvis; shallow, broad and rounded, with wide pubic arch. Bones are delicate. H., Ambrose C., a white ex-soldier, aged thirty-eight, admitted for repair of femoral hernia. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park., Ark.)

Fig. 21. Print from skiagraph: lateral view of same patient shown in Figure 20, illustrating anomalous angle of sacrum with lumbar spine conforming to female type of pelvis. No symptoms referent to spine. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

Fig. 22. Print from skiagraph showing a mild arthritis of spine but of greater interest, a number of anomalies: (1) Lack of union of posterior vertebral arches of fifth lumbar and first sacral segments. (2) Lack of fusion of lateral masses of first and sacral segments. H., Thomas, C., a white soldier, aged twenty-two, admitted by transfer from another hospital for treatment of sequelae of acute rheumatic fever involving all joints of both extremities: valvular heart disease was a complication. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

Fig. 23. Print from skiagraph showing detail of sacrum and coccyx of same patient shown in Figure 22. There are only four segments in sacrum, and none of segments are united by bone; there is evidently a nutritional disturbance. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

Hibbs[8] follows Von Lackum and believes that the important factor in lumbosacral strain is the increase in the angle of inclination of the superior surface of the sacrum to the horizontal, which should not exceed 42.5°; the normal is 25°. He states that by means of skiagraphs taken anteroposteriorly from below, at an angle of 45°, both the lumbosacral and sacroiliac joints can be clearly delineated. This served as the basis for his spine fusion operation in a series of 147 with pain and disability due to developmental defects at the lumbosacral joint. In this series of cases he secured a large percentage of cures.

There can be no disagreement as to sacroiliac dislocation, when in addition to the history of trauma and with subjective symptoms, there is elevation or depression of the posterior superior iliac spine, or displacement laterally. But this is exactly the rock on which the whole discussion splits, for the occurrence of such cases is most rare, and always in association with severe fractures. The *x*-ray appearance cannot be used as corroborative evidence to support a diagnosis of lesser degrees of dislocation, which have been variously termed sacroiliac strains, subluxations, relaxations, etc. There is a paucity of definite findings in these latter cases.

Cox,[4] in writing of sacroiliac subluxation admits as much, when he says: "As strange as it may seem, the *x*-ray offers little help in the diagnosis, positive findings being secured in only 7 out of 300 of Paul Magnuson's series, and in only 3 cases of my series."

One cannot adopt too much of an ex cathedra attitude in this situation. However, the fact remains, that in the majority of these cases, the diagnosis rests on a purely clinical basis. This is a disquieting thought, for treatment predicated on clinical grounds only will continue to be empirical and more or less uncertain in result.

SUMMARY

1. Injury of the lower back has great potentiality for disability.

2. It is most important to correlate the history, symptoms, and laboratory findings, in arriving at a diagnosis.

3. It must be realized that the disability ascribed to sacroiliac and lumbosacral derangement of any, except extreme degree, has very little beyond subjective symptoms to support the diagnosis.

REFERENCES

1. Best, R. R. A contribution to the study of low back pain. *Surg. Gynec. Obst.*, 45: 485–492, 1927.
2. Campbell, M. F. Rupture of the bladder, a clinical study of fifty-five cases. *Surg. Gynec. Obst.*, 49: 540–546, 1929.
3. Colp, R., and Findlay, R. T. Fractures of the pelvis. *Surg. Gynec. Obst.*, 49: 847–853, 1929.
4. Cox, H. H. Sacro-iliac subluxation as a cause of backache. *Surg. Gynec. Obst.*, 45: 637–649, 1927.
5. Forrester, C. R. G. Imperative Traumatic Surgery. Ed. 1, New York, Paul B. Hoeber Inc., 1929, pp. 216–218.
6. Frazier, C. H. Surgery of the spine and spinal Cord. Ed. 1, New York, Appleton, 1918, pp. 325–497.
7. Gray, H. Anatomy. Ed. 18, Phila., Lea and Febiger, 1910, pp. 68–69.
8. Hibbs, R. A., and Swift, W. E. Developmental abnormalities at the lumbosacral juncture causing pain and disability. A report of one hundred and forty-seven patients treated by the spine fusion operation. *Surg. Gynec. Obst.*, 48: 604–612, 1929.
9. Jones, Sir R., and Lovett, R. W. Orthopedic Surgery. Ed. 1, New York, Wood, 1923, pp. 311–345.
10. McWhorter, G. L. Osteomyelitis of the ischium and pubis. *Surg. Gynec. Obst.*, 49: 205–212, 1929.
11. Moorhead, J. J. Traumatic Surgery. Ed. 2, Phila., Saunders, 1921, pp. 575–622.
12. Pancoast, H. K. The Roentgen Examination of the Spine. Chapter IV, Frazier's Surgery of the Spine and Spinal Cord. Ed. 1, New York, Appleton, 1918, pp. 223–264.
13. Whitman, R. Orthopaedic Surgery. Ed. 8, Phila., Lea and Febiger, 1927, pp. 129–132.
14. Wilson, P. D., and Cochrane, W. A. Fractures and Dislocations. Ed. 1, Phila., J. B. Lippincott Co., 1925, pp. 426–446.

IMPLANTATION OF FASCIA IN THE ROUND LIGAMENTS FOR RETRODISPLACEMENTS OF THE UTERUS*

A. P. VASTOLA, M.D., F.A.C.S.

WATERBURY, CONN.

A REVIEW of the literature discloses that over one hundred surgical procedures have been described for the correction of retrodisplacements of the uterus. The majority of these operations have already been justly discarded; the few which have survived all employ the principle that a change in the insertion of the distal portions of the round ligaments shortens their pull and will bring the uterus, according to the type of operation performed, more or less upward and forward. When, fortunately, only the distal halves of the round ligaments are weakened and stretched the permanent results are fairly satisfactory; provided that a relaxed vaginal floor or other pelvic pathology if present, is corrected. The same procedure will not be followed by a permanent cure if applied to round ligaments whose entire lengths have become lax and weak, either as the result of a congenital insufficiency inherent in the tissues themselves, or as a result of failure to undergo a complete involution after the puerperium. It is for the purpose of strengthening two of the main supports of the uterus, and by so doing prevent recurrences, that we are transplanting fascia in the round ligaments, and advocate this procedure in the above type of case as a decided improvement over the standard operations.

TECHNIQUE OF OPERATION

The patient is placed in an extreme Trendelenburg position. An incision is made below the umbilicus a little to the right of the midline, and exposes the sheath of the right rectus muscle for about 5 inches; the sheath is incised the whole length of the skin incision, the peritoneum cut and the pelvis and abdomen explored.

Step 1. The uterine and distal abdominal ends of the right round ligament are grasped with Allis clamps. With a scalpel the peritoneum overlying the top of the round ligament between the two Allis clamps is incised. This incision must not extend into the uterine wall if the patient is of child-bearing age; if the patient is sterile or is made sterile, then the incision over the ligament is carried into the musculature of the uterus. By scalpel dissection, the incised peritoneal covering of the round ligament is deflected to the right and to the left, exposing the muscular fibers of the round ligament. It is imperative at this stage to secure absolute hemostasis in order to avoid a subsequent hematoma.

Step 2. A strip of fascia about ¼ inch in width, free of fat and slightly longer than the dissected round ligament, is excised together with its underlying muscular fibers, from the right leaf of the incised rectus sheath.

Step 3. The fascial strip is now transplanted, care being taken to have its muscular side in apposition with the exposed muscular fibers of the dissected round ligament. In a child-bearing patient, there must be a ¼ inch space between the inner end of the fascial strip and the uterus, in order to avoid an attachment of the transplanted fascia to the uterine wall, and so cause dystocia in future pregnancies. If the patient has been sterilized, then the inner end of the fascial strip is sutured firmly in the body of the uterus. If not, a fine, plain catgut suture is passed through the uterine end of the round ligament and the transplant. The right

* Submitted for publication July 20, 1931.

and left deflected leaves of the peritoneal covering of the round ligament are next sewed over the fascial strip by a continuous

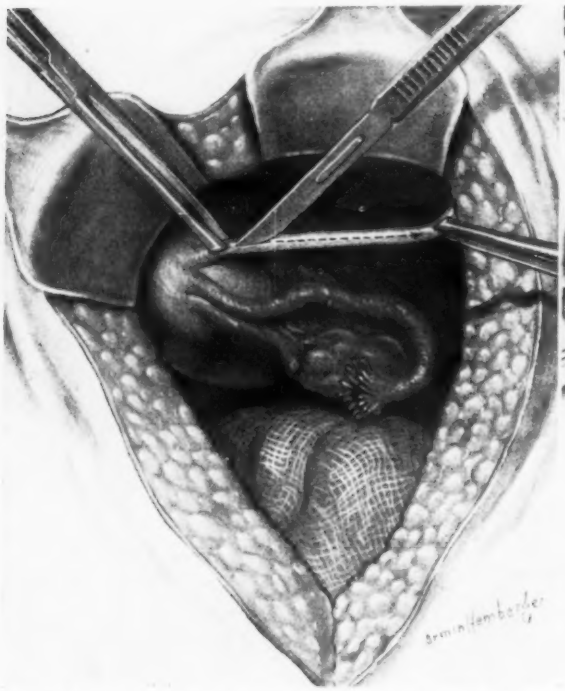


Fig. 1. Uterine and distal abdominal ends of round ligament are grasped with Allis clamps. With scalpel peritoneum overlying top of round ligament between two Allis clamps is incised. This incision must not extend into uterine wall if patient is of child-bearing age; if patient is sterile or is made sterile, then incision over ligament is carried into musculature of uterus.

plain catgut suture, leaving the outer end of the transplant protruding slightly from the round ligament.

Step 4. The same procedure is performed on the left side.

Step 5. Any pelvic or abdominal pathology present, is now attended to.

Step 6. The operation now follows closely the Gilliam technique for a suspension. On each side the round ligament is grasped by an Allis clamp at the point where the outer end of the transplanted fascial strip protrudes; a temporary ligature is placed around it and the ends of the ligature are caught in a forceps. About 1 inch from the margin of the abdominal incision and 1½ inches above the pubic bone a stab incision is made in the aponeurosis of each rectus muscle. In this stab wound an artery forceps is introduced through the rectus muscle and peritoneum,

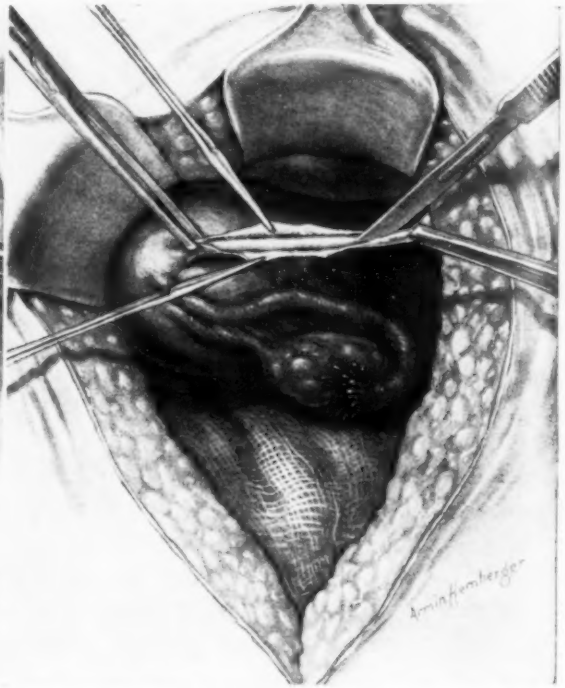


Fig. 2. By scalpel dissection, incised peritoneal covering of round ligament is deflected to right and left, exposing muscle fibers of round ligament.

and the ligature about the round ligament grasped and brought out, bringing both ligament and end of the fascial transplant with it. The loop of each ligament with its transplanted fascial strip is drawn through until the fundus uteri rests well forward. The loop of each side, together with its transplant, is then sutured securely to the aponeurosis of the rectus muscle.

INDICATIONS AND CONTRAINDICATIONS

The operation is indicated in the following types of cases:

1. Retroversion and retroflexion causing symptoms, and where the displacement is due primarily to a congenital lack of tone and muscular development affecting the entire lengths of the round ligaments. Such patients as a rule present other evidence of deficient tissue supporting

strength, such as enteroptosis, diastasis of the abdominal recti, etc.

2. Retroversion produced by repeated pregnancies. In these uteri most of the musculature has been replaced by fibrous tissue, so that the organ is large and hard and has lost its elasticity. This type of case shows a large percentage of partial or complete recurrences following the commonly used suspension operations.

3. Prolapse of every degree; if a procidentia exists and the patient is a poor risk for a more radical procedure, the technique of suturing securely the fascial strips in the body of the uterus is employed. The patient must of course be either in her menopause or artifically sterilized.

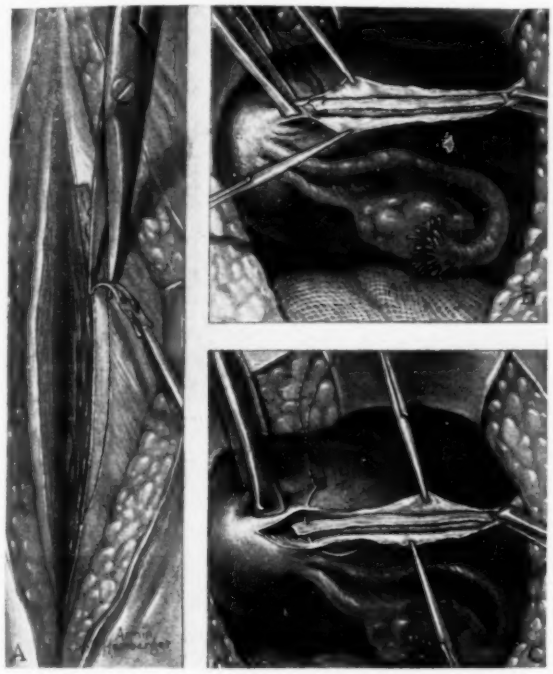


Fig. 3. A. Strip of fascia is excised from right leaf of incised rectus sheath. B. Fascial strip is transplanted with its muscular side in apposition with exposed muscle fibers of round ligament. In child-bearing patient there must be ¼ in. space between proximal end of fascial stip and uterus. Fine plain catgut suture is passed through uterine end of round ligament and transplant. C. In sterile patient incision over round ligament is carried into body of uterus, and inner end of fascial strip is sutured firmly into it.

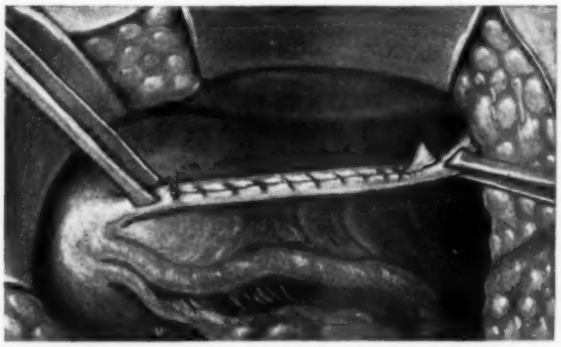


Fig. 4. Right and left deflected leaves of peritoneal covering of round ligament are sewed over fascial strip by continuous plain catgut suture, leaving outer end of transplant protruding from round ligament.

The operation is contraindicated in the presence of either a pelvic or abdominal infection.

SUMMARY

The textbook operations for retrodisplacements of the uterus are followed by a fair percentage of recurrences. This is due to the fact that such operations do not actually strengthen the supporting structures of the uterus which have become weakened, either through acquired or constitutional defects. A method is offered by which the round ligaments are strengthened by transplanting into them fascial strips, so that they can supply the support of missing factors as well as their own quota. In case of pregnancy the round ligaments are still free to undergo hyperplasia and hypertrophy and retain their elasticity. This operation is indicated only when the entire lengths of the round ligaments are weakened and lax; it is contraindicated in the presence of an abdominal or pelvic infection.

NEUROSURGERY IN DISEASES OF THE URINARY BLADDER*

JAMES R. LEARMONTH, CH.M., F.R.C.S. (ED.)

ROCHESTER, MINN.

THE nerves which reach the urinary bladder belong to three systems: (1) the sympathetic division of the autonomic system, (2) the parasympathetic division of the autonomic system, and (3) the somatic system (Fig. 1).

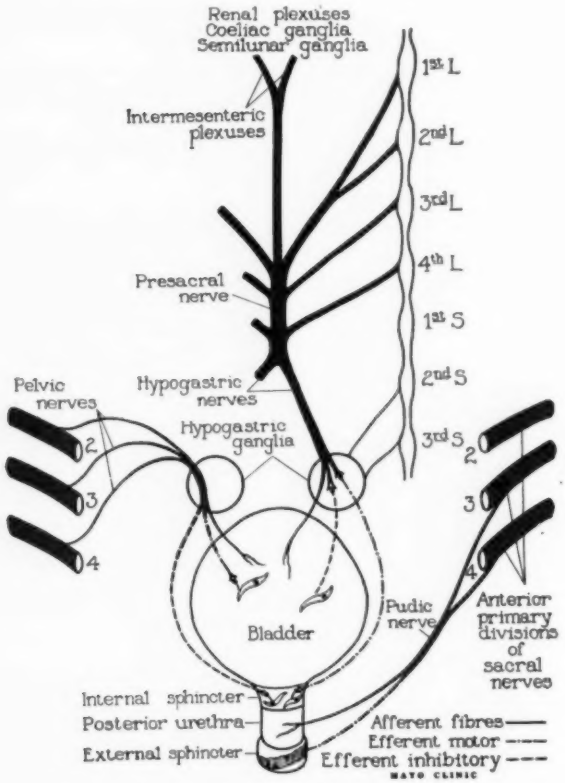


FIG. 1. Diagram of nerve supply to bladder.

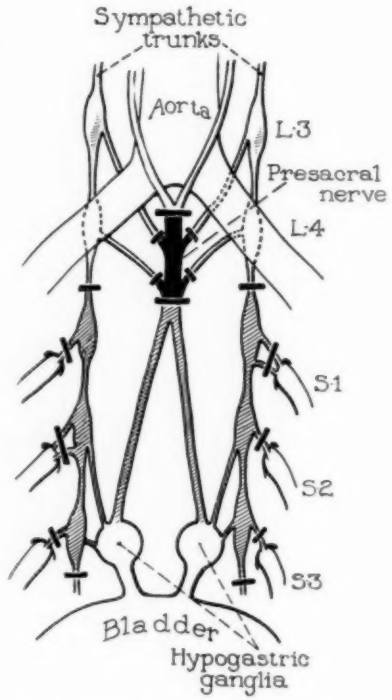


FIG. 2. Pieri's operation for vesical pain. Solid and hatched nerves are interrupted.

ANATOMY

Sympathetic Nerves. Sympathetic fibers for the pelvic viscera, including the bladder, are finally concentrated in a strand termed the presacral nerve. This nerve receives, on each side, a considerable contribution from the first and second lumbar paravertebral sympathetic ganglia; these contributions are termed its lateral roots. A middle root reaches their angle of convergence, from the preaortic nervous plexus, and as such it enters into communication with the celiac, semilunar, and aorticorenal ganglia. Smaller branches connect the presacral nerve to the third and fourth lumbar ganglia on each side. At the level of the promontory of the sacrum it divides into the two hypogastric nerves, which join the posterosuperior angles of the corresponding hypogastric ganglia. The nerve lies in the median line, or a little to the left of it, immediately under the posterior parietal peritoneum. After opening the peritoneum over the nerve,

* Read before the New York Academy of Medicine, December 16, 1931.

all its component parts can be resected by removing the tissue between the left common iliac vein and the right common iliac artery.

Parasympathetic Nerves. Parasympathetic fibers are detached from the anterior primary divisions of the second, third and fourth sacral nerves. They reach the posterior borders of the hypogastric ganglia.

Hypogastric Ganglia. These ganglia form a firm network of nerve tissue; each ganglion lies on a lateral aspect of the rectum. The cells are those of the second relay of the sympathetic path to the viscus; passing through the ganglia, without any such interruption of their courses, are the efferent fibers of the parasympathetic system, and afferent fibers belonging to both sympathetic and parasympathetic systems.

Vesical Nerves. The ultimate nerves to the bladder leave the anterior borders of the hypogastric ganglia, and spread out over the walls of the viscus. From these branches filaments pass to the ureters, the vasa deferentia, the seminal vesicles, and the prostate gland.

Somatic Nerves. Somatic fibers derived from the anterior primary divisions of the third and fourth sacral nerves pass in the pudic nerves to innervate the external sphincter of the bladder; possibly the pudic nerves also contain some afferent sensory fibers from the posterior urethra.

PHYSIOLOGY

The functions ascribed to the various nerves in the following section have been determined in the human being. This point is significant, because the innervation of the bladder differs from species to species, and there may be differences between the sexes of the same species.

Sympathetic Nerves. (1) Closure of the ureterovesical orifices. (2) Contraction of the trigone; both these effects of stimulation of the presacral nerve have been observed with the cystoscope. (3) Closure of the internal sphincter. This has been observed from the posterior urethra, with a Braasch cystoscope, following stimulation of the presacral nerve. Closure can be deduced from the force with which an instrument introduced into the bladder is grasped, following such stimulation. (4) Contraction of the musculature of the prostate gland, seminal vesicles, and ejaculatory ducts. On stimulation of the presacral nerve, the expulsion of seminal fluid into the prostatic urethra can be seen with the cysto-urethroscope. (5) Conveyance of sensations of pain from the bladder. This function has been ascertained by noting the effect of mechanical or electrical stimulation of the presacral nerve, while the patient was under the influence of a low spinal anesthetic. (6) Inhibition of the expulsive mechanism of the bladder. This has been deduced from the immediate active dilatation of the bladder which followed the intravenous administration of epinephrine (a hormonal stimulant for sympathetic nerves).

Parasympathetic Nerves. (1) Initiation and augmentation of the contractions of the musculature of the bladder. Paresis or paralysis of the bladder is known to follow lesions in any part of the parasympathetic pathway, from the sacral cord to the hypogastric ganglia. (2) Inhibition of the internal sphincter. This has been deduced from the fact that the sphincter opens and closes when required, even after division of the presacral (sympathetic) nerve. (3) Conveyance of afferent fibers for the micturition reflex. Micturition can be carried out normally after division of the presacral nerve; therefore, the reflex fibers must traverse the remaining (parasympathetic) pathway. (4) Conveyance of afferent fibers subserving such sensibility as the bladder possesses, for this is unaltered after sympathetic neurectomy.

A study of these functions shows that the sympathetic nerves are "filling" or "storing" in function (dilatation of bladder and closure of its sphincter), whereas the parasympathetic nerves are "empty-

ing" in function (contraction of bladder and opening of its sphincter).

SURGICAL CONSIDERATIONS

Parasympathetic Nerves. The parasympathetic nerves of the bladder are readily accessible only throughout their intraspinal course. Here they are sometimes subject to compression as a result of the congenital malformation termed spina bifida occulta. Not all patients with lumbosacral spina bifida occulta have symptoms referable to the bladder; but there is a group of young adults who may give a history of enuresis in childhood, and who may have urinary difficulty expressing itself in dysuria, perhaps urgency, and the presence of residual urine. With the cystoscope, the internal sphincter is seen to be relaxed, and the wall of the bladder to be finely trabeculated; it is found, also, that the bladder is hypesthetic and has lost some of its expulsive power. In a proportion of these cases, exploration of the spinal defect reveals compression of the roots of the sacral nerves, the relief of which leads to rapid restoration of vesical function; although why the pressure should affect only the visceral fibers in the sacral nerves is by no means clear. Among the compressing agents which may be found at operation may be mentioned fibrocartilaginous bands, masses of fibrofatty tissue, meningocele, and bony excrescences. In many cases, however, exploration for compression is negative; in these the spina bifida occulta is merely an accompaniment of a primary neurogenic defect.

Sympathetic Nerves. Sympathetic neurectomy has been undertaken at The Mayo Clinic in cases of three types:

1. *Paresis of the Musculature of the Bladder.* When a bladder is incapable of emptying completely as a result of injury to any portion of the parasympathetic pathway, it has seemed reasonable to suppose that the intact sympathetic contribution to vesical innervation provided too effective a brake for the decreased parasympathetic innervation, and that after sympathetic neurectomy the diminished activity of the evacuant set of nerves would be unhampered by this brake. Operation has been carried out in eight cases of this type, one of which has been reported in detail elsewhere.[1] One patient in the series cannot be traced, and one failed to receive benefit. Of the remainder, two are considered cured (for periods of two years and one and a half years, respectively), and the expulsive power of the bladder, in the other four patients, has been materially improved; the amount of residual urine has been reduced from 200 to 300 c.c. to 20 or 30 c.c. It is necessary to warn men that after the operation, although they will be able to perform the sexual act and to experience a normal orgasm, ejaculation will not occur; no detectable alteration in reproductive function follows the operation on women. It has been found that after two or three weeks the internal sphincter of male subjects recovers a proportion of its tonus, although the trigone, bereft of its motor nerve supply, remains flaccid. A small quantity of residual urine may persist as a trigonal pool; in these cases a channel is made from pool to posterior urethra by the operating cystoscope, and this operation has often enabled the bladder to expel its contents completely.

2. *Spasm of the Neck of the Bladder.* In two cases in which there was difficulty in starting the flow of urine, a diagnosis was made of spasm, or better, achalasia, of the internal vesical sphincter. In both cases urologic and neurologic examinations were negative, and attempts had been made to rectify the condition by punch operations on the neck of the bladder. Because the sympathetic system provides motor nerves to the internal sphincter, it was thought that its overcontraction would be diminished by sympathetic neurectomy. The operation was immediately successful in both cases, and neither patient

[1] Learmonth, J. R., and Braasch, W. F. Resection of the presacral nerve in the treatment of cord bladder. *Surg., Gynec., Obst.*, 61: 494–499 (Oct.) 1930.

has had any subsequent difficulty in beginning or in completing the act of micturition.

3. *Inveterate Vesical Pain.* Since 1926, when Pieri first performed presacral neurectomy for the relief of vesical pain, a number of successful operations has been recorded. Pieri has devised a more complete procedure, which aims at interrupting all possible sympathetic paths from the bladder to the central nervous system (Fig. 2); this he considered necessary, because one or two fine branches may connect the hypogastric ganglia directly to the sacral paravertebral sympathetic ganglia (Figs. 1 and 2). The complete operation interrupts impulses which, after reaching the hypogastric ganglia, might pass by fibers traversing the paravertebral chains either to the sacral nerves by way of the rami communicantes, and so to the spinal cord, or, after ascending in the paravertebral chain, by way of lumbar or thoracic rami communicantes to the spinal cord at a higher level.

Among the conditions in which this operation has been tested at The Mayo Clinic are interstitial cystitis, inoperable carcinoma of the bladder, chronic cystitis of unknown etiology, and the irritability of the bladder which may remain after nephrectomy for renal tuberculosis. The result has been satisfactory in six of eleven cases. There has not been any marked difference between the result after simple presacral neurectomy, and that after the more extensive operation. The relief from pain is chiefly relief from the pain to which spasmodic and uncoördinated contractions of the musculature give rise. As has been pointed out, the parasympathetic pathway contains many, indeed the majority, of afferent fibers, so that relief of pain, at best, must be incomplete. However, after operation, these patients appear to respond better to local urologic treatment, and this has been directed to increasing the capacity of the bladder, which the operation does not directly do.

In conclusion, I must emphasize that in outlining our experience I am the spokesman of a group, which consists of urologists, neurologists, and urologic surgeons. The operations on the nerves of the bladder which I have described should be undertaken only after most careful and critical examination of the patient, whose preoperative and postoperative treatment must be carried out from all possible clinical angles.

DISCUSSION

Dr. N. P. Rathbun: My reaction to the matter is that these cases will have to be very carefully selected with the very careful cooperation of the neurologist and urologist, and that these cases will not be very great in number.

I have in my wards at the present time a relatively young woman, who, following an operation for some pelvic condition under spinal anesthesia four years ago, has had complete inability to urinate. She was offered some neurological operation, I presume it was resection of the presacral nerve, at another hospital. Her condition at present is so grave from renal infection and stasis that she is in no condition for any kind of surgery. I have another patient with paralysis of the bladder following repeated sacral anesthesias. I am wondering if such a case is suitable for the operation under discussion.

If the work that Dr. Learmonth is doing offers anything to a group of tabetic bladders, of which we all see so many, it will indeed be a Godsend. I have seen a number of these in years gone back where I have been driven to do a permanent cystostomy, which of course is an unsatisfactory operation, but which seemed to offer them more relief than any other thing that we could do.

Dr. Edwin Beer: Experience in this field is very limited, even in large institutions in the big cities. At Mount Sinai, only one case of presacral nerve excision has been done and that in a case of tabes without any improvement in expulsive force. Perhaps in this type of case the disturbance is in the centripetal fibers and naturally it would be foolish to expect any result.

In connection with cases of enuresis in the young and enuresis in adults, Dr. Learmonth has called attention to the finding of a band pressing the dural sac in the sacral region,

and after relief of the pressure by excision of this ligamentum (subflavum) the bladder condition was markedly benefited. These cases have been reported in the Continental literature by numerous writers on numerous occasions. Francois and Delbet have reported several series of satisfactory results. Legueu, on the other hand, has failed on laminectomy in these cases, associated with spina bifida, to even find such misplaced ligaments.

While enuresis in children is a common complaint and may be associated with non-fusion of the lamina of the fifth lumbar or first sacral, enuresis in adults is, in our experience, very rare. Marion in his clinic claims that only one case has been seen, and that a doubtful one, in over 150,000 admissions. In view of these contradictions and difficulty, the question arises, how and when shall we decide to interfere surgically? If a lipiodol intraspinal injection can demonstrate a block at the site of the vertebral pathology or injection through the coccygeal foramen, as recommended by Delbet, can demonstrate a block from below, naturally one can be under the impression that operation for compression of the dura may be indicated, but as yet very few such observations have been made. The recognition of a spina bifida of this type is so common that we hesitate to assign this pathology as the cause of some of the atypical or typical bladder disturbances.

In connection with these cases in children which for years we have been encountering and diagnosing as neuromuscular disturbances or disharmony between sphincter and detrusor, it is just possible that such an operation as has been described by the French (Rochet) and Dr. Learmonth combined may effectively control the spastic sphincter and make for more harmonious muscular expulsion. On the other hand, in the few cases that have come to operation, excision of a wedge at the neck of the bladder has seemed to control the condition completely, and others that were not operated upon, simple dilatations of the sphincter have been effective in establishing normal cooperation between the detrusor and the sphincter muscle.

In connection with stimulation of the detrusor muscle by drugs, Dr. Learmonth in his paper has spoken of the great value of acetocholine, which we have tried, and with the bladder connected with a cystometer we have regularly failed to get any muscular contraction. Again other drugs have been equally unsatisfactory, except pilocarpin, which almost regularly produces an increase in pressure, due to detrusor contraction. Moreover in postoperative retention, pilocarpin is very effective. It would be most encouraging if some pre-operative test could be made by injecting drugs which would clearly show which cases are suitable for presacral nerve resection, which are suitable for hypogastric ganglion resection, and which are suitable for operations on the pudic system. Until further steps are made, in view of the fact that the general nervous system gives no evidence of disturbance in the majority of these cases, progress must be slow and careful so that patients are not unnecessarily submitted to operations of this sort, which will bring the whole experimental study into discredit.

DR. JAMES R. LEARMONTH, *closing:* Not only did stimulation of the central end of the cut presacral nerve give rise to painful sensations which were localized in the bladder wall, but also there was not any complaint of pain referred to the twelfth thoracic and first lumbar segments; these are said to be the somatic segments associated with the pain of overdistension of the bladder.

With regard to Dr. Beer's questions: I have not operated on any patient whose only complaint was enuresis. My patients may have had a history of enuresis in childhood, but the condition which determined operation was paresis of the bladder. Like Dr. Beer, I have been disappointed that in these cases the epidural injection of lipiodol gives little help in determining the presence or absence of compression of the cauda equina. In such cases I think it worth while to explore the region of the spina bifida occulta, and if dural sac compression is present, to relieve this.

I have not, myself, operated on patients whose difficulty in micturition was due to tabes. In such cases, the lesion is probably in the afferent pathway, and one would not expect section of the presacral nerve to help.

The cases most suitable for resection of the presacral nerve are those in which there is evidence of over-balance of the filling or storing set of nerves (sympathetic) to the bladder. These nerves play a part in carrying out the function assigned by Bernard to the whole sympathetic system: regulating the composition of the body fluids.

VESICAL DIVERTICULUM IN THE FEMALE*

LEONARD PAUL WERSHUB, M.D.

NEW YORK

PRIOR to the beginning of the present century, bladder diverticula were only found at the operating table and at post-mortem examinations. Tremendous improvements in modern urological methods of examination have enabled the operator to recognize this condition.

By diverticulum of the bladder, is meant a protrusion, or herniation, outwards, of a part or of the entire wall of the bladder. As a result of this protrusion, a cavity is formed which connects with the interior of the bladder.

Diverticula of the bladder are more frequent than is commonly believed. They are less frequently found in the female. The ratio in females, as compared to males, is about 3 to 97.

There is still a great deal of controversy as to whether diverticula are of congenital origin or acquired. Some authorities believe that as a result of maldevelopment in the muscle fibers of this structure in the embryo, there is a congenital weakness. As a result of this congenital weakness, with subsequent stress and strain of life, herniation occurs.

These problems are purely of academic interest and rarely of any significance in reference to the clinical or surgical problem. It should be borne in mind, however, that obstruction to the urinary outlet is an important factor in the formation of diverticula.

Diverticula are most commonly found when such an obstruction exists, and it is perhaps because of this reason that the condition is most frequently found in the male. At one time it was believed that true diverticula could only be found in males and usually only after middle age. This belief has been repeatedly proved to be false. In addition to the condition being found in females, it is often encountered in children and young adults. As a rule, however, diverticula are most often found beyond the age of forty.

Diverticula may be found in any location within the bladder. The most frequent location is that of the posterial lateral walls near the ureteral orifices. It is less frequent on the lateral walls and least frequent on the dome. Diverticula found on the dome are usually undoubtedly due to a persistence of the urachus. This type of diverticula can be truly called congenital in nature.

Occasionally, as in the case herewith reported, diverticula may undermine the trigone. They occur most frequently singly but may be found in multiple numbers, as in the case reported. There have been cases reported in which a dozen or more diverticula were found.

A common complication of diverticula is infection. It can be readily understood how extension of infection of the bladder to the interior of a diverticulum may occur. Favored by the anatomical arrangement of such a sac, the infection may become persistent and chronic in nature.

Frequently such infection may extend to adjacent structures with subsequent formation of a peridiverticulitis. This explains the frequent findings of fibrous adhesions to either the rectum, wall of pelvis or other adjacent structures.

Formation of calculi, neoplasms, benign or malignant, pressure on ureter and hemorrhage, are other complications frequently encountered. As stated before, such factors of obstruction either at the vesical outlet or in the urethra are pathological findings of great significance.

* From the Department of Urology, Flower Hospital. Submitted for publication July 7, 1931.

In the female such simple pathology as a urethral caruncle has been a frequent finding. In a case reported, this was the first hint of any vesical abnormality existing.

Symptoms: The bladder diverticula may cause no symptoms whatsoever. With infection of the bladder or complications such as vesical calculus or tumor, symptoms become more apparent.

It is the general consensus of opinion that no one symptom is pathognomonic of diverticulum. Disturbances of micturition are usually the first indication of any pathology being present. This is often obscure in the early stages and commonly overlooked. The disturbance may be present at the beginning, during or after micturition.

Difficult urination, frequency and hematuria are signs often indicative of diverticulum, but are of no diagnostic value since these disturbances are frequently found in other bladder conditions.

A very suggestive sign in this condition is that of a very foul urine. The French speak of a pathognomonic sign, the so-called "pis endeux." This is not always present but when present should immediately arouse one's suspicion of a bladder diverticula. The patient will void urine and think he has completely emptied his bladder. To his surprise and usually following a change of position, he will shortly void a large amount of very foul urine. This phenomena is explained by the sudden emptying of the diverticulum into the vesical cavity.

Retention, partial or complete, frequently occurs as well as incontinence. As a rule, retention results due to the pressure of the diverticulum on the bladder neck. In the case reported, retention existed undoubtedly due to obstruction in the urethra. Frequently, where retention exists, the diverticulum will produce a serious clinical picture with chills, fever and prostration. Such condition requires immediate surgical intervention.

In general, it may be said that the symptoms of diverticulum are those of its complications. Symptoms always appear when infection sets in and we are dealing with a diverticulitis. Further, unless complications set in, the diverticulum is symptomless and undoubtedly harmless.

Diagnosis: After a careful history taking and physical examination, it becomes necessary to confirm the diagnosis of diverticula by cystoscopic examination. This is a comparatively simple procedure and only in rare exceptions can such pathology be overlooked. It is of interest to note in this respect that recent literature on this subject warns against overdistension of bladders with multiple diverticula and against unnecessary manipulation. The potential danger of rupture of the bladder is far greater in these conditions than in the normal bladder in a routine cystoscopic examination.

Cystoscopic examination reveals the number and location of the diverticula. It does not, however, give any information as to the size, shape or capacity of the herniation. By means of cystography, we can ascertain the size and extent of the diverticula.

Cystograms are easily obtained and the procedure is indeed a simple one. Sodium iodide (or any of the opaque substances) is most commonly used, though some urologists claim air cystography to be superior. Others resort to the passage of *x*-ray catheters into the diverticulum.

At Flower Hospital we use 20 per cent sodium iodide and find the results most satisfactory. At times, due to the peculiar position of the diverticulum, it may sometimes be necessary to take more than two exposures and at different angles. We always take a plate before filling and one after emptying of the bladder. It is of interest to note at this point that in cases of intravenous pyelography, fairly accurate cystograms are obtained after the dye has been excreted by both kidneys and reaches the bladder.

Treatment: Diverticula of the urinary bladder can only be treated by means of surgical intervention. Non-surgical meth-

ods of treatment are of no value whatsoever and should only be resorted to when operative procedure is definitely contra-

REPORT OF CASE

The following case is reported because of its occurrence in the female with definite signs

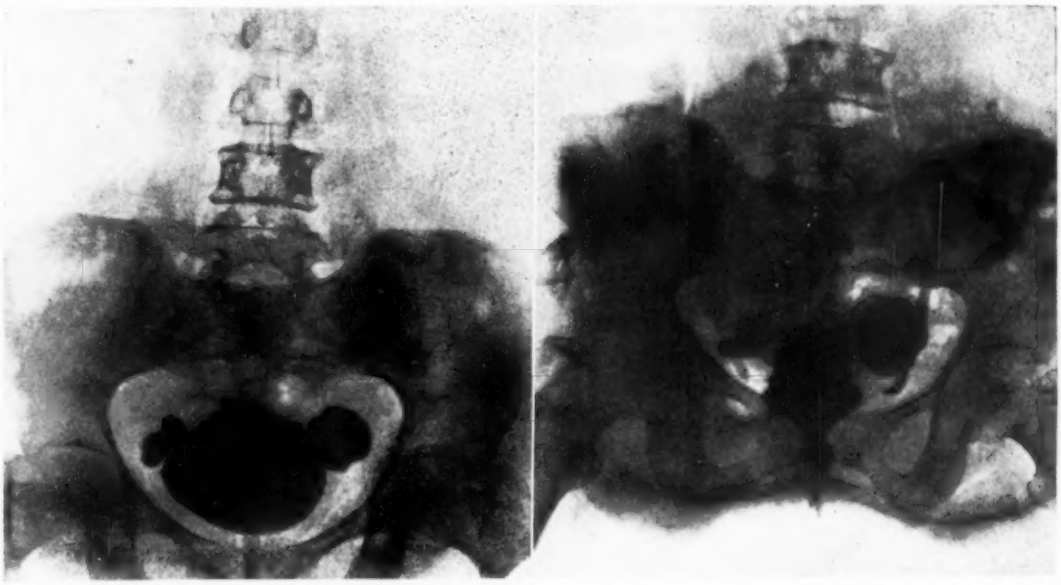


Fig. 1. Cystogram of case reported. Only lateral diverticula are seen.

Fig. 2. Same as Fig. 1, showing retained iodide in diverticula and retrograde movement of iodide up ureters.

indicated. This is determined by the general status of the patient, taking into consideration age, general physical condition and the extent of surgery necessary to correct the deformity. Poor general health, senility, heart disease or advanced pulmonary disturbances, impaired renal function and marked urinary infection often prohibit surgery or make its procedure extremely dangerous.

In the past there have been various surgical procedures recommended, such as suturing of the orifice of the diverticulum without excision of the sac; enlargement of the orifice of the sac; or radical excision of the diverticulum. It is now the general opinion among most surgeons that complete excision is the only satisfactory procedure.

It must always be borne in mind that if complete cure is to be hoped for, it is necessary that whatever obstruction exists, the cause of such obstruction, as well as the obstruction, should be removed.

of obstruction as a possible explanation of the causative factor.

C. J., female, age sixty-three, brought to the hospital by ambulance with complaint of being unable to void.

About twelve years ago she first complained of irritation and burning on urination. In order to urinate patient had to stand. She was formerly hospitalized in Porto Rico, where a growth was noticed at the urethral meatus. This was not treated at the time "for fear of malignancy."

Two months ago patient had a severe attack of hematuria, which subsequently subsided. This is the only history of hematuria that she gives. Her urine has been particularly offensive and foul in the past three months.

Family history is essentially negative. No childhood diseases, a history of rheumatic fevers and attacks of pain in the extremities between the ages of ten and twelve.

Physical examination reveals a thin, somewhat emaciated elderly female, apparently comfortable and with no complaint of pain. Physical examination was essentially negative with the exception of the distended bladder,

which reaches the level of the umbilicus. Furness catheter was passed with some difficulty. At the urethral meatus a papillary raspberry-like growth was seen.

In view of the somewhat vague history concerning the possibility of the urethral growth being malignant, a biopsy was performed. Subsequent pathological report revealed it to be epithelial hyperplasia with chronic granulomatous inflammation (caruncle).

The following day a cystogram was made of the patient, using 20 per cent sodium iodide, which revealed a markedly irregular bladder, with one large diverticulum on the left side and two smaller diverticula on the right side. Following emptying of the bladder, these sacs retain the iodide.

At this time it was noted that there was a retrograde movement of the iodide up the ureter, and an attempt was made to obtain a complete pyelogram by means of a marked Trendelenburg position and overdistension, but this procedure failed.

Subsequent cystoscopy revealed marked papillary cystitis over the entire floor of the bladder, most marked in the region of the trigone. Marked trabeculations were noted. The right and left urethral orifice were visualized without any difficulty.

There was a large diverticulum on the lateral wall of the bladder to the left of the orifice. Two smaller diverticula were seen in the right half of the trigone.

Under general anesthesia routine suprapubic cystotomy was performed. Bladder and diverticula were exposed. The two lateral diverticula were removed with ease. The cavity undermining the trigone was exposed and removed with difficulty. Method of procedure consisted of packing diverticulum with gauze and by blunt dissection sack was removed at the neck. Remaining orifices were sutured; No. 0 chromic for mucous membrane and No. 1 chromic for muscle were used. Cigarette drains were placed on right and left side of bladder. Bladder was closed in routine manner with suprapubic retention catheter sewed to skin with black silk.

Postoperative care consisted in the routine management similar to all surgical bladder procedures. In addition, the caruncle was completely destroyed by the fulgurating current. The urethra was gradually dilated by means of straight female sounds, up to a No. 26 F. Urine was passed freely without any odor or sign of infection.

Conclusions: This case is reported because of the common belief that large, multiple or true diverticula are seldom found in the female. Secondly, because of its association with the urethral caruncle as a factor of obstruction.

It should be noted that in reported cases of vesical diverticula in the female, 90 per cent of them have been associated with urethral caruncle. It therefore follows that females with urethral caruncle of long duration and some vesical disturbance should be investigated for possible diverticula of the bladder.

I am greatly indebted to my chief, Dr. Louis René Kaufman, for his valuable aid and permission to report this case.

REFERENCES

Lewis, D. Practice of Surgery. Vol. 9 (Author).

Eisendrath and Rolnick. Urology. N. Y., Lippincott, 1929.

Braasch. Urography. Phila., Saunders, 1928.

Schacht, F. W., and Crenshaw, John L. Vesical diverticulum in the female. *J. Urol.*, 4: 393, 1930.

Eisenstaedt, J. S., and McDougall, T. G. Bladder diverticula. *J. A. M. A.*, 11: 831, 1931.

Lower, W. E. Diverticula of the urinary bladder. *Surg. Gynec. Obst.*, 52: 324, 1931.

Hinman, F. The etiology of vesical diverticulum. *J. Urol.*, 3: 207, 1919.

Polkey, H. J. Diverticula of the urinary bladder. *Urol. & Cutan. Rev.*, 31: 73, 1927.

Kretschmer, H. L. Diverticulum of the bladder. *Surg. Gynec. Obst.*, 48: 404, 1929.

Rosenthal. Diverticula formation. *Arch. f. klin. Chir.*, 144: 404, 1927.

Kretschmer, H. L. Demonstration of bladder diverticula. *Surg. Gynec. Obst.*, 34: 538, 1922.

Lower, W. E., and Higgins, C. C. Diverticula of the urinary bladder with report of 110 cases. *J. Urol.*, 22: 635, 1928.

SO-CALLED ESSENTIAL HEMATURIAS

ARE THEY CHIEFLY DUE TO URETERAL STRICTURE?*

GUY L. HUNNER, M.D.

BALTIMORE, MD.

RENAL hematuria has long been one of the problems of interest in the diagnosis of abdominal conditions. If we adopt the generally accepted view of today that most kidney bleeding, unassociated with such gross lesions as tumor, tuberculosis, or stone, is due to nephritis or nephritic-like processes, we are still confronted with at least two questions: (1) Why do not all kidneys bleed when they become subject to these organic changes? and (2) What is the mechanism concerned in those kidneys which do bleed?

In the early days of this century Israel,[1] after a ten-year study of the problem came to the following conclusion:

> The result of the analysis of my 14 cases of so-called *népbralgie hématurique*, essential and angioneurotic kidney bleeding, is that there can be shown in most of them organic changes in the kidney or its capsule, or an abnormal mobility.

In 1918 Strauss[2] agreed with Israel that the hemorrhage is due to a lesion in some minute vessel, and he believes that the change from a "drip" or microscopic bleeding to a "massive" or macroscopic bleeding is due to an increase in the intrarenal pressure.

> Although there may be others, the most frequent causes which bring on a temporary intrarenal increase of pressure are rigidity of the capsule wall and compression and strangulation processes at the renal pedicle.

In 1922 I[3] attempted to show that ureteral stricture with its urinary stasis is probably the most important factor leading to increase in intrarenal pressure. I held that stricture with its back pressure is not only the important factor in the immediate attack of renal colic (when present and not due to the passage of clots) and vascular injury, but that by long continued back pressure it has often contributed to the interstitial nephritis present in these cases.

I also attempted to show that focal infections probably play a most important rôle in many of these cases of so-called essential hematuria. Not only do focal infections cause many of the ureteral inflammatory processes resulting in stricture, but in all probability they also cause direct injury to the kidney, resulting in the nephritic-like areas and at times causing a persistence of the bleeding after apparently good kidney drainage has been obtained through wide dilatation of the ureteral stricture. In some of our cases the bleeding has ceased only after a focus of infection has been cleared up. This may mean that the persistent bleeding was due to continued direct injury to the kidney tissues by the focal infection, or that the focal infection kept up an inflammatory reaction in the stricture area, thus resulting in continued back pressure in the pelvis in spite of our apparently satisfactory dilatations.

This leads to the second question: What is the exact mechanism of the bleeding? I think we get our most satisfactory explanation of this phenomenon by referring to the experimental work of those who have studied the problem of "pelvic reabsorption." Hinman and Lee-Brown[4] found by experimenting on living anesthetized animals that they could obtain a pyelovenous backflow by raising the intrapelvic pressure to a point even less than that of the normal secretory pressure for

*From the Department of Gynecology, Johns Hopkins University and Hospital, Baltimore, Md. Read before the Urological Section of the New York Academy of Medicine, October 15, 1930.

the given species. They found that the pelvic rupture would occur in the angle of the deep sulci of the minor calices, and with the phenomena of pain and bladder symptoms, with the development of bleeding from the remaining kidney after a nephrectomy

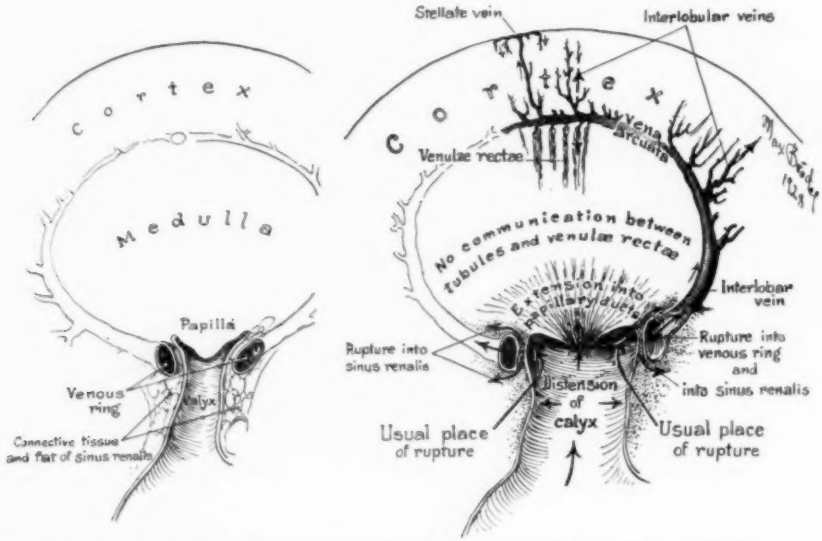


Fig. 1. Mechanism of pyelovenous backflow according to Dr. H. F. Traut.

they thought the backflow took place into the venulae rectae. Traut,[5] working on human autopsy material, found that the rupture in the deep sulcus more often occurred directly into one of the large veins of the inner arcuate system (Fig. 1). He made the significant observation that the low tension ruptures (those at a manometric pressure of less than 100 mm. of mercury, i.e., the normal secretory pressure in the human kidney) occurred only in kidneys taken from a delayed autopsy (thirty-six to forty-eight hours) in which autolytic changes had supervened, or in those kidneys which, though appearing normal at autopsy, were found on microscopic examination to be the seat of nephritis.

The notable array of pathological changes which we have found in the upper urinary tract in our studies on ureteral stricture, and the value of ureteral therapy in the treatment of these conditions, prompts one to turn to the ureteral domain in seeking an explanation for many of the controversial points associated with the subject of essential hematuria.

Some of these controversial questions have to do with the various phases of nephritis, for bleeding, with the questions concerning papillitis, varicosities and apparent angiomata about the papillae, pyelitis follicularis, undue mobility of the kidney, twisted pedicle, shrunken capsule, and passive congestion. Some of these questions were discussed at some length in our previous publication, and with special reference to their relation to the ureteral problem.

Israel thought that unilateral nephritis is not rare and might account for the cases of unilateral hematuria, but Kotzenberg,[6] Kummel,[7] and Strauss all take issue with Israel and believe that the nephritis is practically always bilateral. In dealing with stricture cases we sometimes find pathological elements, such as albumin, casts, erythrocytes or leucocytes, coming from one kidney only, and from this we might conclude with Israel that these are instances of unilateral nephritis. Experience has shown, however, that stricture is almost always bilateral, and more careful investigation of the supposedly normal side in such cases reveals tenderness to palpation, definite evidences of stricture by the bulb investigation, and evidences of changes in the upper tract above the stricture area on urogram tests.

Hinman and Lee-Brown recognize the possibility that some of our clinical hematurias are due to intermittent hydronephrosis, but in carefully devised experiments they were unable by venous injections to get a clear-cut reversal of the pyelovenous backflow. "There occurs,

under conditions of moderate intrapelvic pressure, a backflow of pelvic contents into the renal veins. The degree of back pressure

It is practically impossible, however, in experimental work to reproduce the conditions which we find clinically in patients

Fig. 2 (Case 1). Note enlarged pelvis with filling defect on median border. Note dilated ureter down to a point below pelvic brim.

Fig. 3 (Case 1). Right urogram taken during convalescence. Catheter entirely withdrawn, pelvis and ureter holding 27 c.c. NaI. Note retention area in ureter at point about 6 cm. above ureteral orifice.

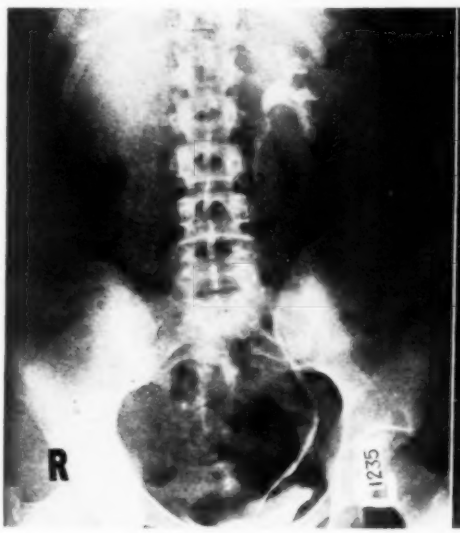


Fig. 4 (Case VI). Note very slightly dilated ureter and calices, almost complete lack of *x*-ray evidence in a ureter which had given serious intermittent trouble for four years, and for which nephrectomy had been advised.

Fig. 5 (Case VI). Note slightly dilated ureter from a point 2 cm. above bladder to kidney. No symptoms on this side, but better *x*-ray evidence of trouble than shown by Fig. 4.

producing it is generally less than renal secretory pressure and, the communication once established, a pressure lower than the initial one keeps it going. *Curiously, relief of pressure is rarely, if ever, followed by hemorrhage.*"

subject to renal stasis such as that caused by ureteral stricture. We know that drainage conditions in stricture patients alter from hour to hour or from day to day. It is characteristic in the early development of stricture in many women that the only period when they show

evidences of stricture, such as renal backache, renal colic, slight fever, frequency of micturition, or renal hematuria, is for a few days at

patient suffers from intermittent renal attacks only after getting the feet wet, getting chilled, taking a long cold automobile ride, during an

FIG. 6 (Case XIV). Note stricture area in broad ligament region with marked dilatation of ureter and moderate dilatation of calices.

FIG. 7 (Case XIV). Note about the same features as in Fig. 6.

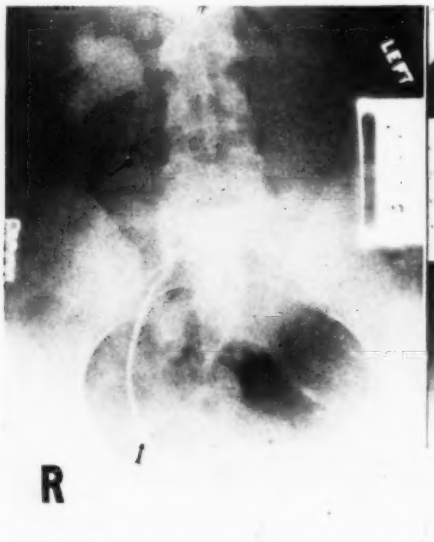


FIG. 8 (Case XVI). Note relatively narrow area in upper abdominal ureter. Hydronephrosis 23 c.c.

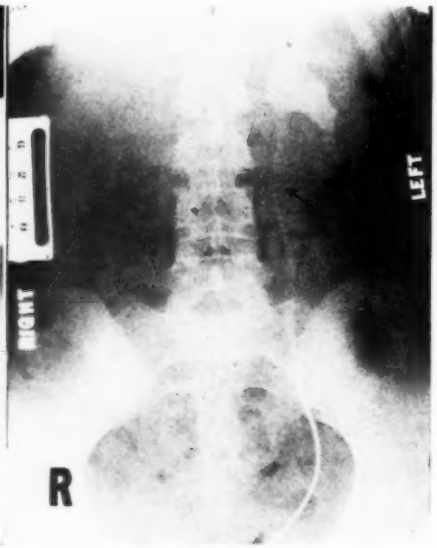


FIG. 9 (Case XVI). Note relatively narrow area in upper abdominal ureter. Hydronephrosis 18 c.c.

or near menstruation. Either immediately preceding, during, or just after the menstrual epoch it seems that added congestion in the stricture areas brings about sufficiently greater interference with drainage to aggravate signs and symptoms only slight or totally lacking at other times.

In some stricture patients the ureters seem to function well for weeks or months and the attack of tonsillitis, sinusitis or toothache, or after surgical interference for any of these conditions.

Is it not reasonable then to explain the intermittency of bleeding in many of these hematuria cases on the theory of intermittent ureteral stasis of a degree sufficient to cause pyelovenous backflow. The prompt cessation of bleeding in most of them as soon as we dilate

sufficiently to give good ureteral drainage affords further confirmation of the causal relation between stricture and hemorrhage, and corresponds with Hinman's experimental observation that relief of pressure is rarely, if ever, followed by hemorrhage.

Many of these patients, it is true, return with bleeding perhaps weeks, months, or years after we have established ureteral drainage, but investigation then shows that the stricture areas have contracted, and further dilatation again brings about cessation of bleeding.

The urologist must remember that one source of failure in relieving any symptom due to ureteral stasis is the overlooking of strictures in the upper ureter. I formerly thought that high strictures are rare, but I have since found that many relative failures in dealing with stricture, both in my own work and in that of others, have been due to the fact that although strictures in the lower ureter had been well dilated, those in the upper ureter had been overlooked and dilated only by the width of the catheter (see Figs. 8 and 9).

If the urogram shows a widely dilated ureteral lumen extending from a low stricture area to the kidney, one may work with the dilating bulb in the usual position 10 cm. behind the catheter tip; but should the urogram show relative narrowing of the upper ureter, this may be due to incomplete filling or to a local peristalsis. On the other hand, if this relative narrowing persists in more than one film, even though it appears to be of the normal 2 to 3 mm. diameter, a bulb placed near the tip of the catheter is likely to demonstrate actual organic narrowing.

Fig. 10 (Case xviii). Note slightly deformed pelvis and lower calices, and incompletely filled but slightly dilated ureter down to an area about 3 cm. above bladder.

Fig. 11 (Case xviii). Note incompletely filled but slightly dilated ureter down to an area about 2 cm. above bladder.

Of course one must be constantly on the alert for other factors that may cause stasis in the upper ureter, such as an abnormal angle of insertion at the pelviureteral junction, lateral pressure exerted by a hydronephrotic pelvis, undue mobility of the kidney with the upper ureter held in good position by periureteral adhesions, and compression of the upper ureter by infiltrated peripelvic fat.

The literature is replete with illustrations of the so-called ureteral "kinks" leading to nephropexies and other operations, while the authors say not a word about the cause of the widely dilated portion of the ureter showing below the kink. Usually these *x*-ray kinks are of good prognosis, since they may merely indicate that the upper ureter, which has dilated in length as well as in width, is prolapsing *pari passu* with the kidney, and that removal of the obstruction in the lower ureter will restore good drainage.

Bumpus[8] apparently questions the generally accepted theory that these hematurias are due to a nephritis, on the ground that a review of the cases treated in the Mayo Clinic shows such a large proportion of the patients in apparent good health for years after their period of hematuria.

In our ureteral stricture work we meet with patients with apparently serious damage to their kidney tissues due to the ureteral stasis, which has resulted in bilateral hydronephrosis,

in infection of one or both pelves, in bilateral nephritis with pelves smaller than normal, or in bilateral calculus of an extreme grade.

The proposed new viewpoint on the so-called essential hematurias has had the reception one expects for any idea that promises a

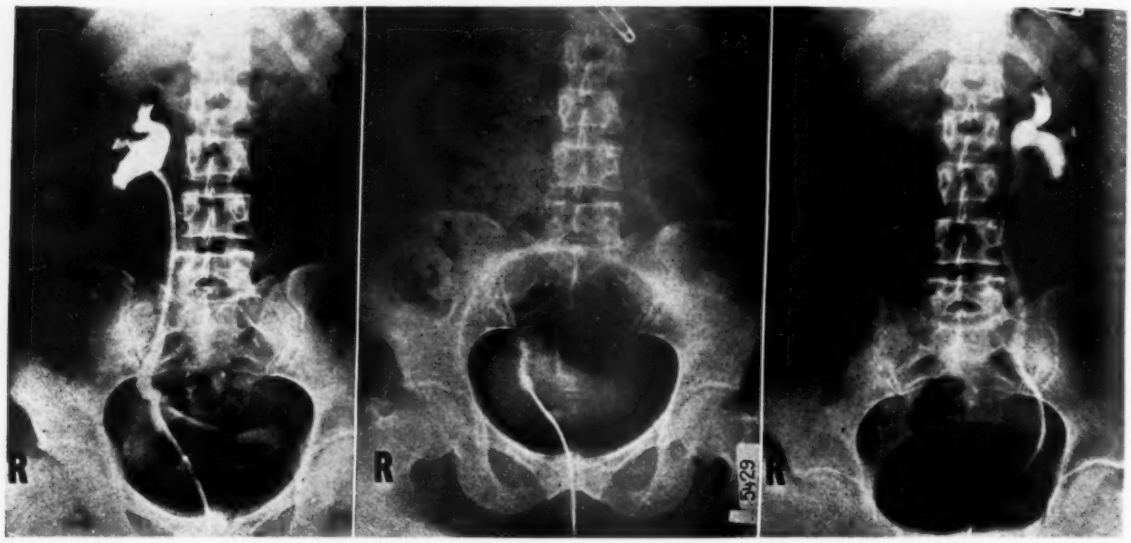


FIG. 12. FIG. 13. FIG. 14.

FIG. 12 (Case XX). Moderately enlarged and deformed kidney pelvis and calices. Dilated ureter with narrow area just above slightly filled ballooning sac at ureterovesical region.

FIG. 13 (Case XX). Better filling of ballooning sac with narrow area just above. It is probable that the narrow area represents site of a stricture symmetrical with stricture found on left side, and that the dense infiltration of ureteral os resulted in dilatation of entire tract above, thus preventing a 5 mm. bulb from picking up stricture area in juxtavesical region.

FIG. 14 (Case XX). Catheter withdrawn until bulb hangs in a stricture area 3 cm. above ureteral orifice. Note moderate dilatation of tract above stricture area, with relatively wider dilatation of upper and lower calices.

These patients may have a two-hour phenolsulphonphthalein output in the neighborhood of 10 per cent, and yet, after restoration of good ureteral drainage and employment of the appropriate renal treatment, these patients not infrequently develop a two-hour phenolsulphonphthalein output of more than 50 per cent and live for many years in surprisingly good health, some of them even carrying pregnancies through to a successful issue.

Surely one would not argue from these facts that the kidneys of such patients were not suffering from nephritis or nephritic-like processes in the days of their treatment; nor would one argue that because the urinalysis seems perfectly normal ten years later these kidneys would not show old pathological changes.

Bumpus states: "That the disease can hardly be of nephritic origin, *as nephritis is usually understood*, seems clear in this study." The phrase which I have italicized scarcely saves the argument, for in spite of the volumes published on nephritis there are few terms in medicine about which we have such vague and contradictory ideas.

revolution in traditional methods of dealing with a serious situation. Personal communications from men working at stations scattered over the entire globe have shown that others are having gratifying results by using the methods suggested, but so far as I know, Livermore[9] is the only other worker who has published a report on cases of hematuria due to stricture. The attitude of the leading urologists, who should be the first to investigate any method promising such possibilities of conservatism, in dealing with a situation hitherto but little understood, has been one of indifference. This is perhaps best illustrated by the fact that my five minute discussion before the American Urological Association at its New York City meeting in 1918 (where, in a symposium on essential hematuria, I first presented urograms on a series of cases successfully treated by ureteral dilatation), was apparently considered of such fairy tale quality that it was entirely eliminated from the published records of that meeting. Ten years later, and six years after my first formal publication, the publication by Bumpus mentioned before, who makes a fairly exhaustive review of the literature on

the theories concerning the etiology of essential hematuria, completely ignores the ureteral stricture theory.

Hoping that the assembling of further data on this controversial subject may possibly stimulate careful investigation by some of the more conservative of the urological group, and knowing that it will encourage those who are already using the methods advocated, this paper is presented for the purpose of bringing my studies on hematuria up to date.

In the ten years from June, 1920, to June, 1930, I find 200 cases indexed under hematuria, after excluding a few cases which overlapped on this period and were reported in my first paper.

Two in this list of 200 were particularly interesting cases occurring in the practice of my associates; with one patient I came in contact in consultation and with the other merely in a discussion of the urograms. In some of the dispensary cases the care of the patient was entirely in the hands of the house staff.

Stricture of the ureter was found in 174 of our 200 cases of hematuria. In 22 cases examination of the ureters was not made, either because the source of the hematuria was so obviously of bladder origin or because investigation was refused.

In 4 cases examined for possible stricture this lesion was not found. In 1 of these, a patient with exophthalmic goiter, the urine showed microscopic pus and blood but we could find no lesion of the urinary tract to account for these pathologic elements. In one a primary ureteral papillocarcinoma was found. In one an edema of the trigonum was found and the bulb test showed infiltration of the bladder wall. In the fourth case, that of a thirteen-year-old child, there was great hypertrophy of the bladder walls, vesicoureteral reflux with considerable dilatation of the ureters and pelves, but the diagnostic bulb revealed no hang. While the bilateral colon bacillus pyelitis improved after wide dilatation and repeated pelvic lavage, the bleeding did not cease until bad tonsils had been removed. The macroscopic hematuria coming from the left kidney had been present constantly for thirteen days before our first investigation and for another twenty-five-day period during our dilatation and lavage treatment, and within four days of the tonsillectomy there was a brisk hemorrhage from the left fauces resulting in a drop of blood pressure from the former level of 210/160 to 165/120. The bleeding from the throat was promptly

Fig. 15 (Case xxiii). Urogram with catheter out. Note stricture area about 3 cm. above bladder with moderate dilatation of tract above.

stopped with a suture and within a few days the old level of hypertension was regained; but from the time of this hemorrhage the blood in the urine ceased. This leaves us with the question as to whether the tonsillectomy or the postoperative hemorrhage with its consequent sudden fall in blood pressure was the deciding factor in curing the renal hemorrhage. Two and one-half years later the report shows that the child still has a blood pressure of around 200/130 but that she had been attending school and is in fairly good condition. The urine shows a specific gravity of 1013, and contains a trace of albumin and a few leucocytes. Blood has not been found microscopically since her return home.

Of the 174 patients in whom ureteral stricture was demonstrated, calculus in the upper tract was a complication in 37, tuberculosis in 8, and renal tumor in 2 cases. Of the 8 hematuria cases associated with tumor, in 3 hypernephroma was found, 2 of these patients also having ureteral stricture, as just mentioned. One had a primary papillocarcinoma of the ureter, and 4 had a bladder tumor.

When ureteral stricture is present with stone, tuberculosis, or tumor of the upper

tract, no one can say what share the stricture has in the hematuria.

The hematuria was ascribed to a pyogenic cystitis in 23 cases, although 15 of these patients were found later to have stricture associated with the cystitis. Of the 13 patients with interstitial cystitis or elusive ulcer it so happened that all of these were found to have bilateral stricture, and in some of them we demonstrated that the bleeding was coming from the upper tract rather than from the bladder. It is characteristic of the elusive ulcer that, although microscopic blood can usually be found, this type of ulcer seldom gives rise to a macroscopic hematuria. If, therefore, one is dealing with a patient who gives a history of macroscopic hematuria, and the only evident lesion is an elusive ulcer which is not bleeding actively when examined, one should not fail to investigate for possible ureteral stricture.

A history of a former pyelitis was obtained in 7 cases, 4 of these supposedly bilateral. Pyelitis was found to be present in 25 cases, 16 of these being bilateral. A hydronephrosis of 10 c.c. or more was recorded in 65 cases, 16 of these being bilateral.

Fig. 16 (Case xxiv). Right kidney and ureter holding 24 c.c. NaI. This side held 50 c.c. four years previously. Note outline of a shrunken right kidney.

Fig. 17 (Case xxvii). Left urogram with catheter removed. Note moderate dilatation of ureter from stricture area (3 cm. above bladder) to kidney. Normal-appearing pelvis, slightly enlarged and clubbed calices.

Chronic pyelitis and hydronephrosis are recognized as common complications in the so-called essential hematuria cases, and I hardly need emphasize that in the large majority they are due to ureteral stricture.

In résumé, then, we may subtract from our 174 cases of demonstrated ureteral stricture the cases with the following complications as a possible or probable cause of the hematuria: stone 37, tuberculosis 8, tumor of the upper tract in which stricture was found 2, elusive ulcer in which stricture was found 13, pyogenic cystitis or ulcer in which stricture was found 15, a total of 75 cases. This leaves 99 out of the 200 cases of hematuria in which stricture of the ureter was the only lesion found to account for the blood in the urine.

I realize that some will not agree that the 25 cases of demonstrated pyelitis, and 65 cases of hydronephrosis, in all of which ureteral stricture was demonstrated, may be ignored as having complications which cause the so-called essential hematuria. Fourteen of the 25 cases in the pyelitis group also belonged to the hydronephrosis group, and I am convinced that time will demonstrate the truth of my contention that these complications, like the

TABLE 1

No.	Patient	Age	Para	First Consulted	Hematuria								Treatment					Results	
					Duration	Continuous	Intermittent	Gross	Microscopic		Right Kidney	Left Kidney	Operations	Ureteral Dilatations				Hematuria	
									Reported	Found				Right Side		Left Side		Ceased	Continued
														Times	Size Fr.	Times	Size Fr.		
I	Mrs. E. A.	28	..	Nov. 1929	20 days	+	..	+	..	+	..	+	Nephrotomy L.	..	..	1	11	1 year	
II	Mrs. A. B.	26	2	June 1926	2 years	..	+	+	+	..	..	..	Nephrect. L.	17	18	7	..	4 years	
III	Mrs. E. B.	35	1	Dec. 1925	2 years	..	+	+	..	+	..	..	.....	7	18	9	16	5 years	
IV	Mrs. M. B.	32	8	May 1930	6 years	..	+	+	..	+	..	+	.....	4	15	6	15	4 months	
V	Mrs. H. deC.	26	..	Nov. 1925	4 days	+	..	+	+	+	+	..	.....	7	15	2	4	4 years	Tuberculosis of right kidney and bladder apparently developed after 4 years
VI	Mrs. M. E.	39	..	Jan. 1926	4 years	..	+	+	+	+	..	+	.....	4	17	7	16	4 years	
VII	Mrs. G. G.	37	2	Feb. 1926	18 months	..	+	+	+	+	+	..	.....	2	16	2	16	3 years	
VIII	Miss T. H.	20	..	July 1929	3 years	..	+	+	+	+	..	..	.....	3	16	3	16	18 months	
IX	Mrs. F. H.	36	2	Nov. 1922	3 years	..	+	+	+	+	..	..	.....	..	..	5	17	8 years	
X	Mrs. F. H.	32	0	May 1920	6 years	..	+	+	+	..	..	..	.....	2	14	..	..	8 year	
XI	Mrs. K. K.	36	0	Jan. 1920	5 months	..	+	+	+	+	..	..	.....	1	14	..	..	6 years	
XII	Mrs. S. K.	29	2	Apr. 1930	2 weeks	..	+	+	+	..	..	..	.....	5	17	3	14	8 months	
XIII	Mrs. A. L.	41	0	June 1927	17 years	..	+	+	+	+	..	..	Nephropexy	12	17	11	17	1 year	
XIV	Mrs. F. M.	33	0	Nov. 1929	2 days	+	..	+	+	+	+	..	.....	6	16	4	15	1 year	
XV	Mrs. M. M.	30	4	June 1930	3 months	+	..	+	+	+	+	+	.....	3	14	3	17	On admission Hb. 60 per cent, r.b.c. 2,700,000. Condition improved but bleeding continued. Patient ceased coming.	
XVI	Miss N. McC.	36	..	Sept. 1922	2 years	..	+	+	+	+	..	..	.....	9	17	9	18	3 years	

TABLE 1 (*Continued*)

No.	Patient	Age	Hematuria										Treatment						Results	
			Para	First Consulted	Duration	Microscopic							Ureteral Dilatations						Hematuria	
						Continuous	Intermittent	Gross	Reported	Found	Right Kidney	Left Kidney	Operations	Right Side		Left Side			Ceased	Continued
														Times	Size Fr.	Times	Size Fr.			
XVII	Miss E. N.	20	..	Jan. 1924	4 weeks	+	..	+	+	+	+	..	.....	6	14	6	14	2 years	Then intermittent hematuria 4 years to Nov. 1930. A few long interval treatments elsewhere. Possibly insufficient dilatation	
XVIII	Mrs. E. O.	31	2	Oct. 1924	6 years	..	+	+	+	+	..	..	.....	3	16	1	11	6 years		
XIX	Mrs. S. R.	35	3	Nov. 1925	6 years	..	+	+	+	+	..	..	.....	..	..	2	15	Letter May, 1930 says, "Still having same symptoms but cannot stand the treatments"		
XX	Mrs. B. R.	36	6	May 1929	5 years	..	+	+	..	+	..	..	.....	2	15	2	14	18 months		
XXI	Mrs. C. R.	66	4	May 1929	6 years	..	+	+	+	..	..	..	.....	4	17	4	17	18 months		
XXII	Miss C. R.	65	..	Oct. 1929	1 year	..	+	+	+	+	..	..	.....	14	12	13	11	Intermittent treatments 1 year, greatly improved but still microscopic bleeding. Died—Diphtheria		
XXIII	Mrs. M. S.	55	2	May 1929	9 months	..	+	+	+	+	..	..	.....	8	17	7	17	1 year	Then symptoms including hematuria returned. Recent treatments, hematuria ceased	
XXIV	Miss S. S.	77	..	Oct. 1922	9 years	..	+	+	+	+	..	..	.....	6	17	4	15	3½ years		
XXV	Miss A. T. S.	28	..	Apr. 1924	6 years	..	+	+	+	..	..	..	.....	7	17	6	17	6 years		
XXVI	Mrs. N. W.	32	1	Nov. 1928	3 months	..	+	+	..	+	..	..	.....	3	15	3	16	2 years		
XXVII	Mrs. Y.	49	2	Mar. 1930	4 weeks	+	..	+	..	+	..	+	.....	..	..	4	15	9 months		

hematuria, are merely secondary to the stasis caused by the stricture.

Of these 99 patients (in whom stricture was the only lesion found to account for the hematuria) there were 49 whose history of bleeding was such as to justify a classification under the traditional term of essential hematuria. In order to forestall criticism, however, I have still further restricted the list to 27, as representing those patients whose bleeding was so profuse or so prolonged that the most critical could not deny them the usual classification under idiopathic or essential hematuria.

Space forbidding a detailed report on these cases, I have arranged the following table as a summary of the important data relating to the bleeding, the treatment, and the end-results.

It will be noted that all of these patients had noticed macroscopic bleeding, and in 21 instances the attending physician reported microscopic blood, while in only 22 cases was blood found on admission of the patient. In some of these sufficient ureteral dilatation had already been done to cause a cessation of bleeding but not enough to relieve the patient of other symptoms.

In several of those for whom the chart shows a large number of ureteral dilatations the bleeding ceased after the first or second dilatation, but the patients returned because of other symptoms.

FIG. 18 (Case v). Film taken November 14, 1925. Note jonquil type of pelvis, lower calices not filling. Slightly dilated ureter down to broad ligament region.

FIG. 19 (Case v). Film taken March 10, 1926. Compare with Fig. 18, and note marked change in position after patient had gained in weight. Calices all filled. Blurring of pelvic outline due to movement of patient because of pain caused by removal of bulb through lower stricture areas.

Some patients are entirely relieved of the hematuria and sufficiently relieved of other symptoms by two or three treatments on either side and then cease treatments even though advised that they should persist until a higher dilatation is obtained. A few months later they return because of the reappearance of blood or of some of their former symptoms.

Others persist in bleeding in spite of apparently adequate dilatation until some focus of infection is removed.

In order to present a few urograms of the type of patients under discussion, and to emphasize some of the therapeutic points discussed in this paper, the following condensed case histories are submitted,

their numbers corresponding with those in the preceding table.

Case 1 (Figs. 2 and 3), illustrating a case of persistent bleeding, without visible improvement after the first ureteral dilatation. The urogram suggested a filling defect that might have been due to tumor. The hemoglobin continued to decline. Nephrotomy on the nineteenth day of the hematuria.

E. A. (colored), aged twenty-eight, 5 para, youngest three years old. Admitted November 16, 1929, because of macroscopic hematuria. November 10, the patient went to bed at 10 P.M. feeling perfectly well. At 1 A.M. November 11, she was suddenly awakened with an intense knifelike pain in the left kidney region. This pain subsided after an hour of hot compresses. The following morning she voided urine suggesting pure blood, and all voidings in the next five days showed macroscopic blood. Just before each voiding there was a sharp pain in the left lower quadrant which subsided immediately after the bladder was empty.

On admission the temperature was normal, blood pressure 130/80, hemoglobin 50 per cent, white blood corpuscles 4880. The left kidney was not palpable and there was no tenderness in this region. There was tenderness on palpation of the left ureter at the pelvic brim, and greater tenderness on palpation of the ureter in the broad ligament region. Here the ureter could be palpated and felt as if thickened by an edema rather than by tuberculous infiltration. On cystoscopy and after evacuation of a considerable amount of dark bloody urine the bladder mucosa was found to be normal. Bloody urine was seen to be coming from the left ureteral orifice. (No note on the right orifice.) The left side was catheterized with a No. 8 renal open end catheter carrying a 4 mm. (12 Fr.) wax bulb. Urine looking like pure blood was secreted freely. Two *x*-ray films were taken, the first a flat *x*-ray showed no evidence of stone, the second, a urogram (Fig. 2) showed a fairly widely dilated abdominal ureter with angled convolutions in its upper portion, a moderately dilated renal pelvis, and calices of fairly clean-cut outline and moderate dilatation. The pelvis showed a dark shadow or filling defect on its median border strongly suggesting a tumor, but which, in view of all the findings, I interpreted as a blood-clot. The upper portion of the pelvic ureter showed slight reflux of the NaI solution beside the catheter, and some of the solution had reached the bladder. The lower half of the pelvic ureter was filled by the catheter. On withdrawal of the catheter the 4 mm. bulb had a moderate hang at 11 cm. from the external urethra or at about 6 cm. above the ureteral orifice. Slant agar culture from the left kidney urine showed a heavy growth of Staphylococcus albus.

The macroscopical bleeding persisted after this first dilatation, and the hemoglobin steadily declined, registering on Nov. 18, 47 per cent, Nov. 21, 39 per cent, Nov. 23, 36 per cent. On Nov. 23, a blood transfusion was given and the hemoglobin registered on Nov. 24, 44 per cent and on Nov. 26, 41 per cent.

I concluded from our tests that the patient had ureteral stricture and I was strongly tempted to try the effects of one more ureteral dilatation, but because of the absence of visible results from the first dilatation, and especially because of the filling defect in the urogram, which suggested a possible tumor of the pelvis I decided to explore the kidney by operation.

On Nov. 30, two weeks after admission, a left exploratory nephrotomy was done. The kidney was found to be of about normal size and was free from adhesions about its lower two-thirds. Its upper third was densely adherent, and the adrenal gland was considerably mutilated in freeing the upper pole. After delivering the kidney we found a depressed scar across its upper anterior face. The pelvis was distended by a soft mass which felt like a blood-clot. The kidney was split from pole to pole by the Brödel incision. After the washing out of the blood-clot careful inspection failed to reveal any point of bleeding. The two halves were apposed by square sutures of plain No. 2 catgut. Pelvic drainage was established by leaving two Dakin tubes.

On Dec. 15, sixteen days after operation, a one-hour intravenous phenolsulphonphthalein test showed a total of 510 c.c. with 70 per cent of the dye, a surprising result especially in view of the later findings on investigation of the right side.

On Dec. 28, examination revealed a stricture in the right ureter symmetrical with that in the left and a kidney pelvis holding 27 c.c. (Fig. 3).

We have been unable to get this patient back for further study and treatment, but on Dec. 7, 1930, we learned from a relative that she has had no further bleeding, and her only complaint is "weakness across the back" when her position in service becomes particularly hard.

Case VI (Figs. 4 and 5). Mrs. M. E., aged thirty-nine, admitted in January, 1926, presents a particularly interesting history from the viewpoint of focal infection. Her troubles began in December, 1921, when she experi-

enced pain in the left kidney region and macroscopic hematuria which persisted in all voidings for four months. In April, 1922, she entered a hospital for tonsillectomy. Her left kidney pain ceased before she left the hospital, and within two weeks of the tonsillectomy the hematuria ceased. She remained well for three years, and then, for one year before consulting me, the pain in the left kidney region and the hematuria had been about constant. She was said to have had six cystoscopic treatments on the left side between March and August, 1925, and had been advised to have the left kidney removed.

I was much surprised to be unable to get even a fine whalebone filiform to enter the left ureter more than 3 or 4 cm. It was not until my fourth attempt at ten-day intervals that a catheter was carried to the left kidney. Both sides were finally well dilated, the left to a 5.3 mm. (16 Fr.) bulb and the right to a 5.6 mm. (17 Fr.). The left kidney, which had been condemned for removal, yielded a half-hour intravenous phenolsulphonphthalein of 20 per cent against 30 per cent on the right.

A letter from her physician, Dr. S. M. Crisp of Greenville, N. C., on June 4, 1930, states that the patient has had no bleeding since her treatment, and has some pain in the left kidney region only when she stands too long or fails to drink water freely.

Case xiv, (Figs. 6 and 7). Illustrating a case of only forty-eight hours of severe hematuria.

Mrs. F. M., aged thirty-three years, widow, referred to Dr. Leo Brady Nov. 5, 1929. Menstrual history normal except for an intermenstrual flow of three days' duration, ten days ago. Her regular period now due. Four or five days ago developed a pain in the right flank, radiating into the bladder. Two days ago the urine became bloody and this feature rapidly increased to an appearance of pure blood. On Nov. 6, cystoscopy showed that the blood was coming from the right ureter. Bilateral catheterization was instituted and a urogram was made of the right side. This was a poor film but it showed a filling defect in the right pelvis which was interpreted as due to blood-clot or tumor. There was much pain for the first twenty-four hours, but the bleeding was distinctly less in amount. During the second twenty-four hours the pain returned in the right kidney region and the urine again was like pure blood. During the third twenty-four-hour period the patient ceased voiding and only 30 c.c. of urine were obtained by catheter.

I saw the patient with Dr. Brady at midnight a few hours after she had been given intravenously 500 c.c. of 25 per cent glucose solution and just after she had been given a hot tub followed by a hot pack. At the conclusion of the hot pack and during our consultation she expressed a desire to void and passed 300 c.c. of slightly bloody urine. From that time her recovery was uninterrupted and Dr. Brady later obtained the urograms shown in Figs. 6 and 7. During her period of suppression the patient was mentally sluggish and drowsy and the non protein nitrogen registered 70 mg. At Dr. Brady's request I made the final examinations and ureteral dilatations on Feb. 5 and 8, 1930. The patient had fully recovered and had no symptoms except a slight lumbar backache when working hard and at the menstrual periods. The urine was normal, and the pelviureteral capacity was now 16 c.c. on the right and 11 c.c. on the left.

Case xvi (Figs. 8 and 9). History on patient's first visit of intermittent bleeding over a period of two years. Persistence of this intermittent bleeding over another period of three years in spite of repeated wide dilatation of strictures in the lower ureters and tonsillectomy. Finally, on review of old urograms (Figs. 6 and 7), we concluded that high strictures might be present. These were found by the bulb test and after another two years of intermittent bleeding and treatments the patient has been free from all symptoms for three years.

Miss McC., aged thirty-six, referred in September, 1922, by Dr. Richard Bell, Staunton, Va. About two years ago, during a bad head cold, the patient noticed what she thought was blood in the urine. This lasted about one week and as there were no other urinary tract symptoms the patient ignored it. About six months ago, while nursing members of the family ill with influenza, she was taken with an attack of what was diagnosed as intestinal influenza. The patient was perfectly well on Sunday night and on Monday morning she awakened with great nausea, a raging headache, severe backache, pains down the legs, and blood in the urine. There was fever only on the first day. These symptoms persisting, she was kept in bed for eight days, when the bleeding and other symptoms ceased. Ten days after she got up hematuria appeared again and disappeared after a week in bed. During this attack bladder symptoms began as pain and soreness referred to the bladder and urethra. Later she began to have much aching and soreness in both sides of the pelvis. Three months ago cystoscopy was done followed in forty-eight hours by severe right renal colic. Since then she is often awakened after three or four hours of

sound sleep by a peculiar heavy feeling in the right kidney region and she can shift her position in bed only with great care. Repeated examinations of the urine during the past four or five months have been negative, and the urine on her admission was normal. Her chief complaints on admission seemed to be referable to the genital rather than to the urinary tract. There occurred intermittently a miserable feeling through the entire lower abdomen, extending from the umbilical region down through the pelvis and into the perineum. There was a bearing-down sensation as if the pelvic organs were about to come out. These symptoms were exaggerated at the menstrual period.

Bilateral stricture was found and two dilatations were given on each side during September and October, and in November a tonsillectomy was performed. She returned in March, 1923, five months later, reporting that there was much less of the old pain low down in the pelvis, but she had developed considerable backache for the first time in her life, when lifting or doing extra work. She gets very tired and is easily played out since her tonsils were removed in November. On this visit she had one treatment on each side with a 5 mm. bulb, and in April another treatment on each side with a 5.6 mm. bulb on the right and a 5.3 mm. on the left.

She returned one year later in March, 1924, saying that she had felt very well for three months after the previous treatments, but that in July, 1923, the hematuria had reappeared. She remained in bed for a time and felt better in September and October than she had at any time for several years. Then in January, 1924, she was overworking and had hematuria again and had had it practically constantly for the three months before coming except when she remained in bed. The left side seems to give more discomfort, there often being a pain through the lower left quadrant which makes her feel that she must keep the left leg flexed. Her most nagging discomfort is a feeling as of a heavy weight in the region of the symphysis. No recent bladder symptoms.

She had 5 treatments on each side from March until June, 1924, the dilatations being carried to a 6 mm. bulb on the right, and a 5.6 mm. on the left.

In March, 1925, Dr. John Neff, of the University of Virginia, wrote me that the patient had consulted him because of a return of her bleeding and because she was living near him and wished to save the expense of the long trip to Baltimore. In reviewing her case for Dr. Neff I got out her *x*-rays and was impressed by the comparatively narrow areas in the upper ureters and I wrote Dr. Neff that if he would put his bulbs near the tip of the catheter he might find that she had high strictures as well as the low ones which I had been treating so thoroughly. Dr. Neff found this to be the case and treated her off and on for two years. According to a letter received in October, 1930, she has been entirely well and free from symptoms of any kind for the past three years.

Case xviii (Figs. 10 and 11). Mrs. E. O., aged thirty-one, admitted Oct. 4, 1924, because of macroscopic hematuria. Since the birth of her first child seven years ago the patient has never been free from a burning sensation in the bladder which always appears just after voiding and lasts for several minutes. Every October since 1918, or for six years, she has had an attack of hematuria lasting two to three weeks. Each of these seasonal attacks has been accompanied by a sore throat.

The patient was undernourished, and the hemoglobin was only 49 per cent. Her tonsils were small but definitely diseased. The hematuria coming from the right kidney ceased promptly after three dilatations up to a 5.3 mm. (16 Fr.) bulb. The left ureter was dilated once only with a 3.6 mm. (11 Fr.) bulb. The tonsils were removed Nov. 8, 1924.

In May, 1930, our Social Service Department learned from a sister that the patient had left the city and that she was not in good health but the sister thought she had not had further bleeding.

Case xx (Figs. 12, 13, 14). Mrs. B. R., aged thirty-six, admitted May 1, 1929. Married sixteen years, 6 para, the youngest child being seven years of age. For five years the patient had been having attacks of bladder pain and great frequency. These attacks come on once or twice a month and last from one to two days, but between attacks she is entirely free of symptoms. During the attacks she has to void every two or three minutes, and has severe pain and occasionally has noticed blood in the urine with these attacks. There was considerable microscopic blood in the bladder urine on admission.

Eleven years ago she was operated on for appendicitis and suspension of the uterus. Two years ago she had an operation for an ovarian tumor and perineal repair. Since this her symptoms have been considerably worse.

The right ureteral orifice could not be located but was probably the site of a stricture, which was causing a ballooning of the ureterovesical wall into the bladder. An oblong to cone-shaped, bluish cystic mass projected into the bladder with about a 15 mm. elevation (Fig.

13). The left stricture was located 3 cm. above the ureteral orifice. The ballooning mucosa was opened with the fine-pointed alligator scissors, and while the urograms all show a narrow area in the lower right ureter, in the broad ligament region, just above the ballooning area, yet a 5 mm. bulb showed no hang in this region. On the left side two dilatations were made, up to a 4.6 mm. (14 Fr.) bulb. On her return home in May the patient was advised that she would need to return in the fall for further ureteral dilatations.

A letter from the patient on Oct. 9, 1930, says that she has been considerably improved but that she has had a few of the bladder attacks, not as bad as they were formerly. She has also been having some pain in the kidney regions which she had not noticed before the ureteral treatments. She had not seen any blood in the urine.

Case xxiii (Fig. 15). Intermittent hematuria for nine months before consultation. Return of hematuria about fifteen months after treatment, but great improvement in general health.

Mrs. M. S., admitted May 1, 1929, aged fifty-five years, 2 para, youngest child twenty-three. The patient has been in ill health for the past twelve years with attacks of pain in the upper left flank and a drawing sensation extending up into the left shoulder and into the back of her neck. At times has severe attacks in the right lower quadrant, a grabbing pain so severe she has to remain a few moments in a fixed position. With these attacks there is a great frequency of voiding and apparently an increase in the amount of urine. Frequently there is incontinence of urine unassociated with laughing, coughing, sneezing, or any form of physical strain. One of her most disagreeable symptoms is that of a great nervousness or restlessness coming on with the attacks and preventing sleep and impelling her to ceaseless activity even of an aimless character. She says her physicians have never been able to do anything for her relief except to give her hypodermics of morphine. The patient was operated upon six months ago, the diagnosis being a Bartholin's abscess, left; salpingitis, chronic, bilateral; appendicitis, chronic; adhesions about gall bladder. She had consulted another surgeon just before I saw her and had been advised to have a repair of the outlet. She stated that her complaints on admission were the same as those before her operation. She had noticed blood in the urine intermittently for about three months before her operation, and since the operation there had been three severe spells of hematuria, each lasting from four days to a week. Her physician stated that he had examined the urine about once a week since her operation and always found microscopic blood, and frequently a smoky to red urine macroscopically.

On admission, macroscopically, the urine was bloody and contained albumin (4+), an occasional leucocyte and a bladder culture of Bacillus coli. The blood was found to be coming from the right side. Each kidney was the seat of an infected hydronephrosis, slightly less than 1 oz. During May and June, 1929, the ureteral strictures were dilated on either side 3 times up to a 5 mm. (15 Fr.) bulb. The patient returned in September, 1930, and reported better health than she had had for many years. About five weeks previously she had noticed a gradual onset of her highly nervous and agitated state that used to precede the severe attacks of pain in the flanks and the bladder symptoms. A week later a soreness began in the right lower quadrant together with the appearance of blood in the urine. She has noticed blood daily in the past month, and for the past two weeks there has been slight discomfort in both upper flank regions. It was found that the blood was again coming from the right side. Four dilatations, up to a 5.6 mm. (17 Fr.) bulb were given on each side during September and November, 1930, after which, on cessation of all symptoms, the patient was discharged with instructions to return if any should reappear.

Case xxiv (Fig. 16). Illustrating "essential" hematuria at an advanced age. Miss S., aged seventy-seven years, admitted in October, 1922. Pain in right back fourteen years, often nausea and vomiting with this pain. Bladder symptoms nine years, with passage of brownish material in the urine during the first four years of this period. Microscopic examination during this time showed blood and pus. Blood has been present many times since and was supposed to be due to bladder ulcers. Many *x*-ray examinations for stone in the kidney and many cystoscopies.

Two years ago, in a neighboring clinic, a diagnosis was made of right ureteral stricture and hydronephrosis of 50 c.c., with microscopic examination of the right kidney urine normal. At that time there was blood in the bladder urine and bloody urine was seen to be coming from the left side. The right ureter was dilated to a No. 10 Fr. but nothing was done on the left side. The urine became clear and the patient was dismissed. She remained comfortable for about a year and then again developed a pain in the right kidney region, irritation of the bladder and bloody urine. She returned to the same clinic where cystoscopy showed a normal bladder. An attempt

to catheterize the right ureter failed and nothing further was done until ten months later when the patient was referred to me.

About one month previously she had had one of her attacks of severe pain in the right kidney region with nausea and vomiting; no fever. She was still complaining of pain and soreness across the back, and urinary frequency. There had recently developed a nagging uneasy feeling in the left lower quadrant "where the ureter enters the bladder." The urine was normal, blood pressure 155/75, a one-hour intravenous differential phenolsulphon phthalein showed:

Right, through catheter, 10 minutes, 20 c.c., 17 per cent
Left, through bladder 4 minutes, 60 c.c., 30 per cent

The right kidney and ureter had a capacity of 50 c.c. The patient improved rapidly under dilatation of her bilateral ureteral strictures, and remained well for four years. She returned in April, 1927, saying that in the fall of 1926 she was having unusual physical activity and again developed a pain in the right hip and flank regions, and later a pain in the right back. These pains have been intermittent and when present there is bladder irritation and frequency. With the onset she sent a specimen of urine to her physician who said it was normal. On readmission we found the catheterized bladder urine normal except for the presence microscopically of many erythrocytes. The two hour subcutaneous phenolsulphon phthalein showed, first hour 30 per cent, second hour 8 per cent. Blood pressure, 160/78. Hemoglobin, 68 per cent.

At the first cystoscopy the following day the urine was normal. The patient remained in the hospital for twenty-three days and both ureters were dilated to a 15 Fr. The right side, which four years previously held 50 c.c., now held 24 c.c. (see Fig. 16).

On sending out the questionnaire in September, 1930, I figured that, if living, the patient would now be eighty-five years of age, and I expected to have a return report by some member of her family. A happy report from the patient says that she is still "going strong" and without urinary tract symptoms.

Case xxvii (Fig. 17). Illustrating the case of a patient with symptoms for twelve years fairly typical of ureteral stricture. After three weeks of searching investigation on the medical service a diagnosis was reached of "psychoneurosis." Then the patient was fortunate enough to develop a gross hematuria which led to the true diagnosis of ureteral stricture.

Mrs. M. Y., aged forty-nine years, admitted to the Medical Service March 20, 1930, complaining of a dull aching in the epigastrium, constipation and headache. Twelve years previously the patient had noticed a gradual onset of rather sharp pain in the left upper quadrant and across the epigastrium, accompanied by dull headache, gas with eructation, anorexia, loss of weight and general fatigue. Her pains in the upper abdomen were rather constant and had no relation to meals. She was finally kept in bed for six weeks and a diagnosis was made of visceroptosis. Later she complained of intermittent dull pain in the left lower quadrant, and about the left sacroiliac region. Several years ago she had an attack lasting for several weeks of frequency and burning on micturition. Eighteen months ago she began having blurring of vision and edema about the eyes. She had had the usual diseases of childhood, including occasional attacks of tonsillitis. Four years ago, at the age of forty-five, she began having irregular and profuse menstruation, and was told that she had a tumor of the uterus. Treatment by x-ray was followed promptly by the menopause.

During her first three weeks in the hospital exhaustive studies were made of the various organs and systems with the exception of the urinary tract. In spite of her suggestive history, this omission of the urinary tract was probably based on the traditional notion that a normal urine means a normal urinary tract.

On April 12, three weeks after admission, the patient began complaining of frequency of urination with severe pains in the right thigh and lumbar region, and a catheterized specimen of the bladder urine contained macroscopic blood. On April 13, Dr. TeLinde was asked to see the patient and suggested a complete urological investigation as soon as the patient's acute symptoms subsided. That night the patient had an attack of sharp pain in the left lumbar region without fever, chill or nausea and orders were given to save the urine carefully for investigation for calculus. The urine was stained for tubercle bacilli with negative results, and the culture from the bladder was negative. Macroscopic blood persisted in all voidings for ten days. Then, on April 22, Dr. TeLinde made the first investigation, finding bloody urine coming from the left side, and the left kidney took 18 c.c. of NaI for the urogram. A 4 mm. bulb had a hang at a point 2 to 3 cm. above the bladder (Fig. 17).

The left kidney urine was negative except for the blood.

The half-hour intravenous phenolsulphon phthalein showed:

	Appearance Time	Amount	Per Cent
Left (catheter)	8 minutes	20 c.c.	10
Right (bladder)	5 minutes	30 c.c.	25

After the second dilatation on the left side the bleeding ceased entirely. The dilatations were carried up to a 15 Fr. bulb after which the patient was discharged as well.

In spite of the fact that the patient left the hospital most grateful and happy that she had been entirely relieved of symptoms of twelve years' duration, her final diagnosis was headed with "Psychoneurosis," probably as a slight reward for her obstinacy in not yielding positive findings during her first three weeks in the hospital.

The disease under discussion is frequently referred to in the literature as "symptomless unilateral hematuria." That this is an inaccurate description becomes manifest at once to anyone who takes careful histories and closely follows the developments in the individual patient in even a short series of cases. The condition is seldom symptomless, and the patient may present herself today with the hematuria entirely from one kidney, but a month later may return with another attack of hematuria, and examination reveal that the bleeding is from the other kidney, or perhaps from both. It is a well recognized fact that the patient who has undergone a unilateral nephrectomy for a so-called essential hematuria not infrequently returns because of bleeding from the remaining kidney.

In this series of 200 patients, who came complaining of macroscopic hematuria or in whose first catheterized bladder specimen microscopic blood was found, we demonstrated ureteral stricture in 174, as previously described. A careful analysis of the symptoms in this series of 174 cases yields the following table which will be of great significance to anyone familiar with ureteral stricture work.

Two of the 174 cases or 1.7 per cent may be classified as symptomless, these patients having presented the one complaint of macroscopic hematuria.

The tabulated symptoms were as follows:

	Per Cent
1. Pain located definitely in the kidney region	68
2. Backache, some of these also classified under (1)	50
3. Pain in the lower pelvis (ureteral ?)	51
4. Dysmenorrhea	20
5. Pain in the hip	10
6. Pain extending down the thigh	17
7. Pain referred to the perineum	6
8. Dyspareunia	5
9. Headache	34
10. Gastrointestinal symptoms	39
11. Fever, including the pyelitis cases	29
12. Bladder symptoms	84

Most patients who come because of ureteral stricture complain of at least two or three of the symptoms listed here, and in carefully obtained histories one finds that not a few patients with stricture cover practically the entire list.

The best evidence that such an array of symptoms may be dependent on the presence of stricture, and consequent urinary stasis, is the satisfactory proportion of patients who cease complaining of these symptoms after adequate ureteral drainage has been established.

Having a working familiarity with the various methods advocated in the past thirty years for the cure of the condition known as essential hematuria, I have no hesitation in stating that we have never before been able to make such a record as is presented in this table. With a list of 27 patients chosen from 99 of a similar character, because of the extreme degree or long duration of their bleeding, we find, (1) that only 3 of the patients were submitted to kidney operations: Case I, a left nephrotomy after one ureteral dilatation and the persistence of threatening hematuria; Case II, a left nephrectomy (a year after the bleeding had ceased) because we had determined that the left kidney was functionless, but still continued to cause pain; and Case XIII, in which, before admission, the patient had been submitted to a bilateral kidney fixation without apparent influence on her bleeding.

In our hands only 1 of the 27 patients (Case 1) underwent a kidney operation because of bleeding.

Three of the 27 patients have had what we consider poor results: Case XV, a colored woman, who had but 3 dilatations on each side and then ceased treatments before we had an opportunity to refer her to other departments for investigation for possible foci of infection; Case XVII, a nurse, who ceased bleeding for two years after ureteral dilatations, but has

had intermittent bleeding again for the past four years. She lives at a distance and has had some treatments in the past four years, but we do not know how thorough these have been; Case XIX, a colored woman who had two treatments on the most painful side and then decided she could not stand more treatments.

Case XXII, a sixty-five year old patient died of diphtheria one year after beginning treatments, was still having microscopic bleeding, but her improvement in general health after many years of invalidism was most satisfactory in spite of the unusual density of her strictures which had permitted of a dilatation to only 4 mm., 12 Fr., with 14 dilatations on the right, and to only 3.6 mm. (11 Fr.) with 13 dilatations on the left.

Case VII may be eliminated as an ideal result because the patient continued to bleed until the end of her pregnancy after being dilated to a 15 Fr. when she was four to five months pregnant. Since delivery she has had four months without bleeding although her chief attacks of hematuria in the past four years have followed immediately after each of three childbirths.

Case V might also be eliminated as an ideal result, for after treatments in 1925 and 1926, resulting in a cessation of bleeding for four years, the patient returned in July, 1930, with hematuria, and a tuberculous right kidney was found. During her intermittent treatments in 1925 to 1926, there had been no bladder symptoms, and cystoscopy had always revealed a normal bladder and normal ureteral orifices. In spite of the fact that we never found leucocytes in the urine our routine investigations during this time record on Nov. 11, 1925 a slide for examination for tubercle bacilli as negative, as well as guinea-pig inoculations from the bladder urine in April, 1926, and from the right kidney urine in December, 1926, as negative. The chest examination and *x*-rays in November, 1925 resulted in a diagnosis of "slight infiltration of both sides—tuberculosis."

From these facts and because of improvement in general health and absence of hematuria for four years after our ureteral treatments I think the tuberculosis of the right kidney was a later development probably favored by the stasis due to ureteral stricture. Figures 18 and 19 show a remarkable change in the position of the right kidney within four months. The patient had 3 dilatations of the right side, up to a 5 mm., 15 Fr., bulb on Nov. 3, 14, and Dec. 8, 1925. She ceased bleeding, gained in general health, and increased in weight, but returned in March, 1926, because of reappearance of the bleeding. After 3 dilatations in March and April she did not bleed again until November, 1926. After two dilatations she did not see blood again for nearly four years when she returned in July, 1930, with hematuria, severe bladder symptoms, and a much ulcerated bladder. Tuberculosis of the right kidney was demonstrated.

Excluding 9 cases in which the results were not ideal (although ureteral treatments were of distinct value in most of them) we record 18 patients in the preceding table or 66.6 per cent who obtained what we may term ideal results from no other treatment than ureteral dilatations and attention to focal infections. Of course some of these may return at some future time with further bleeding and in need of more dilatations, and some may return having developed a kidney infection, a neoplasm, calculus, or tuberculosis; but the treatment given to these patients would render the occurrence of such incidences (except for a neoplasm) far less likely, and such recurrences would not detract from the value of the methods advocated.

CONCLUSIONS

1. The preceding analysis of 200 cases of hematuria seems to indicate that ureteral stricture is the most frequent cause of renal bleeding, and that stricture, together with its frequent background of focal infection, accounts for practically all those cases formerly diagnosed as idiopathic or essential hematuria.

2. It may seriously be questioned whether these terms are of further practical value in our diagnostic work, and whether they should not be discarded because their use tends to promote loose thinking, inaccurate observation, and erroneous therapeutics.

3. We believe that ureteral stricture is one of the most important factors in the development of hydronephrosis, renal infections, renal and ureteral calculus, and renal tuberculosis; and we know from experience that the lesion is of such common occurrence that it is sometimes found in association with neoplasm. We may

therefore sound the important warning that the finding of ureteral stricture in association with renal bleeding does not for a moment relieve the diagnostician from the responsibility of further exhaustive studies to determine whether stricture and a distant focal infection area are the only factors responsible for the hematuria, and especially to determine at the earliest time possible whether neoplasm is developing in the upper urinary tract.

Dr. Oswald S. Lowsley: I have been familiar with the intensive work of Dr. Hunner since 1910 when I was a student in Baltimore and heard his first talks; and now after this last thorough presentation I feel that he has certainly "put it over." Today there are very few people who will not admit that there is such a thing as stricture of the ureter. For some years it was questioned as to whether it ever occurs; but I was convinced early and firmly believe that it is a very important matter to be considered: in fact, I developed one myself, and was relieved by dilatation.

The matter of painless hematuria is one of the most fascinating questions in urology, and when a patient presents himself or herself with that sort of history the urologist is often taxed to the uttermost to determine the cause; but the fact that stricture does play so important a part in the condition has just been shown so clearly that I need not discuss that point. I would, however, like to say a few words concerning 2 cases that have come under my observation that were most interesting and somewhat baffling.

The first patient presented himself with a history of painless hematuria on three occasions. On the first two of these occasions he was examined thoroughly by me, but we found no apparent cause for the bleeding; he had no infection of the kidney; no bacteria grew from culture, and the pyelogram showed nothing. We then did bilateral pyelograms; the more baffling the case, the more interesting it became. Each time that the patient came his history was studied thoroughly; but finally, when reviewing the situation on the third occasion we learned that the painless hematuria had followed an attack of Coryza during which the patient had been confined to his home. We are all aware of the fact that the urinary tract is irritated by any infection anywhere, so we were considerably baffled by the fact that we did not get bacteria from the urine. Then we went into the question of treatment: Each time he had a cold, he took salol and went to bed. After learning that, we persuaded him not to take salol, and since then he has never had any signs of hematuria. That is one point that I wished to mention.

We all know that bladder irritation shows various symptoms, and we see them in cases of stricture frequently without bacteria or pus in the urine. We also see lesions of the bladder without bacteria; but there is another type of case which simulates this, too, and for which the urologist must be on his guard. I firmly believe that there is a trophic bladder condition occurring chiefly in women, especially those who have either passed the menopause or else had an artificial menopause; in these cases the symptoms are relieved not by local treatment, but by the administration of some of the glands of internal secretion.

Dr. N. P. Rathbun: Both idiopathic hematuria and stricture of the ureter are very large subjects, which leave room for almost endless discussion. Dr. Hunner's explanation of why stricture of the ureter would account for bleeding and connecting it up with the work done by Hinman, Lee-Brown and others is very plausible. Years ago we used to speak of idiopathic hematuria as an end diagnosis, knowing at the time that it was really an incomplete diagnosis. In the earlier days we were satisfied with a 15 per cent margin. That has gradually narrowed down to 5 per cent or less and Dr. Hunner's work may well narrow it still further. Many cases of course prove after careful study to be cases of early tumor, early tuberculosis or stone not opaque to the *x*-ray. These will often be determined by a later examination. I was glad to hear Dr. Hunner emphasize the point that many of these cases that bleed sometimes present also pain as a symptom. I have also noted this. He also stresses the point of their usually being bilateral. I have no doubt this is true in many cases but I have followed some over long periods of time, which apparently were unilateral. There is another factor which I have noted in some of these cases of obscure bleeding and which I reported in a paper some years ago. We have all attempted at times to explore these kidneys, doing various things such as decapsulation, nephrotomy, etc. In 2 of the patients upon whom I performed a nephrotomy I was obliged a few days later to do a nephrectomy for secondary severe bleeding. Careful study of the kidneys removed showed them to contain numerous areas of what I interpreted as old scars, which represented acute infections perhaps many years before. Of course we all know that many severe cortical infections of the kidney get well spontaneously and that abscesses may rupture

in the calices or tubules and it is reasonable to believe that these cases leave scars which may be a factor in producing symptoms of hemorrhage and pain in later years. I quite agree with Dr. Hunner about the importance of checking up on focal infections in all of these cases. I have enjoyed these pictures and this presentation and think that the most important point of Dr. Hunner's contribution lies in his clinical reports and his results. Many persons may doubt many of his theories about strictures in the ureter and there are perhaps relatively few people who go all the way with him in his attitude toward this subject, though we cannot doubt his veracity and he certainly presents many cases with clear clinical histories and cures maintained over a long period of years. In other words, he delivers the goods.

Dr. A. R. Stevens: The very fact that there has been so much difference of opinion regarding the frequency of strictures the writer has added stimulus to our work and has caused us to study our cases more intensively.

Six or eight years ago I published a paper calling attention to a certain group of cases which appeared early to fall into the category of so-called idiopathic hematuria. These cases were investigated, but no cause for the painless hematuria was found. After periods varying from four months to fifteen years, the mysteries were solved by the establishment of usual diagnoses: tuberculosis, stone, tumor. I am sure Dr. Hunner will not object to our placing a little stress on that point, that even though a painless hematuria may yield after some simple procedure, it is wise to keep such patients under observation, and to bear in mind the possibility of that case ultimately coming into one of the ordinary groups of pathological lesions which cause bleeding. In my own work I have come across a group of individuals who have had painless hematuria and in whom I have found stricture. I cannot put my finger on any particular record indicating that the bleeding has stopped after the passage of bougies.

The very plausible explanation of how stricture operates as a factor in producing hematuria is interesting. It seemed hardly plausible that blood came from the strictured area itself. I was impressed by Dr. Hunner's statement that he has stopped irrigation of the renal pelvis in stricture cases. It has always seemed to me that dilatation was the important factor. Also, I think that in many of the reports we have had in the past of painless hematuria having been stopped after the passage of a catheter and perhaps one irrigation of the kidney pelvis, emphasis has been wrongly placed on the irrigating fluid (adrenalin or silver nitrate). If Dr. Hunner's deductions are correct, the passage of the ureteral catheter should have been given greater credit in these reports.

Dr. Howard S. Jeck: I think Dr. Rathbun's remarks about Dr. Hunner's "delivering the goods" should be emphasized. I know of two women, whose symptoms puzzled several good men, before they finally reached Dr. Hunner. He found definite evidence of ureteral stricture in both patients and both were very definitely relieved.

I think Dr. Hunner's work probably explains many of the mistaken diagnoses which occurred particularly in the early days of pyelography. Not infrequently a kidney, removed because of the diagnosis of renal tumor, proved to be normal. Such diagnoses were often based partly on a pyelogram suggesting tumor but largely on the predominant symptom of painless hematuria.

Recently I had a case that emphasized to me more than any other the possibility that hematuria may be a symptom of ureteral stricture. A man came to me with every evidence of stone, typical attacks of colic and hematuria. I had some very careful *x*-ray pictures made and no shadows suggesting stones were observed. A urogram showed one of the most definite ureteral strictures I have ever seen. From the vesical orifice upwards for at least 2 in. there was simply a thread of shadow representing the lumen of the ureter. Above the stricture the ureter was dilated. The passage of the catheter incident to making the urogram gave the patient complete relief.

Dr. T. J. Kirwin: I am sure that the younger members of the Urological Section have been very glad to hear Dr. Hunner's paper. I regret that what is known in Europe as "the American disease" has now become an actual disease in France, Germany, and England.

Dr. Guy L. Hunner (*closing*): Some fifteen years ago I was bold enough to read before the Urological Society my first paper on ureteral stricture. The discussion that night did not seem quite fair to some of your members, for they came to me after the meeting with apologies, and asserted that the members assaulting my views did not mean to suggest that I did not know what I was talking about, nor did they mean to class me with Ananias; but for any man to state that he had seen 50 cases of any disease as rare as ureteral stricture was rather more than they could swallow.

I assured them that I had not taken the numerous frank opinions as an insult, and told them that my results on my patients had been such that I felt certain they would find

stricture as often as I if they simply looked for it. It is naturally more agreeable to be met as I have been tonight with a large percentage of agreement and a little disagreement. But it is only by disagreement and viewing a problem from all angles that we finally arrive at the truth.

Dr. Lowsley's loyalty in presenting himself as a stricture victim is beyond measure. He brings up the case of the man with a bad cold and with urinary tract symptoms and a hematuria. Further investigation showed that the hematuria was probably due to his medication. Dr. Lowsley expressed his surprise that the urine did not show infection. But this is almost characteristic in these cases of urinary tract inflammations secondary to focal infections, be the inflammation located in the urethra, trigonum, or ureter. The symptoms may be quite aggravated but the urine is negative or only slightly altered, and does not show an infection. If the kidney has derived a stasis we may find infection in the urine, but this is usually secondary and by the colon bacillus rather than by the streptococcus or staphylococcus, the probable original invaders of the urinary tract tissues from the distant focus of infection.

The same idea probably applies to Dr. Rathbun's cases, the two kidneys which he was obliged to remove because of severe persistent bleeding without evident cause, and in which he found old scars in the kidneys. These scars probably represented direct injury to the kidney tissues by past focal infections. The kidneys may have been invaded directly by the cocci of the focal infection or by their toxins, but it is quite possible that the urinary stream never had more than a temporary invasion of the cocci, and by the time the patient comes with the scars and the bleeding the urine is negative to culture.

Another class of cases of which I am not certain that I have seen a good example, but which I think we should bear in mind when looking for obscure causes of urinary tract irritation, are those described by W. W. Duke of Kansas City as due to anaphylaxis from foods, which produce toxins in certain individuals.

Dr. Rathbun said he had not found many cases with bilateral kidney bleeding. You all know that many authors have written about "unilateral symptomless hematuria," but this is not a good descriptive phrase for these cases as a class. A careful history will reveal in most of them at least slight kidney or ureteral discomforts, or slight bladder symptoms, and while many of them are bleeding from one side only when they are first examined, you often find when the patients come at subsequent visits that they are bleeding only from the opposite side, or perhaps from both sides at the same time.

Dr. Stevens properly laid stress on those patients in whom you find nothing to account for the bleeding when they first come, but perhaps months or years later you find they have stone or tuberculosis. Did they have the stone or tuberculosis at the time of your first examination? Some of them probably did, but no doubt some of them had only ureteral stricture which you did not have in mind, and consequently overlooked in your first examination, and the stasis from the stricture may have been the chief factor in the subsequent development of stone or tuberculosis.

I have tried to show you that we are dealing with a large family group of pathological processes in the kidney such as stone, tuberculosis, hydronephrosis, chronic pyelitis, and renal hematuria, all of which revert back with a strong inheritance to the parentage of that one simple lesion, stricture of the ureter. I have had a number of patients develop stone in the ureter while being treated for stricture. A little too much trauma in the stricture area may result in bleeding, temporary ulcer, and increased blockage, ideal conditions for the accumulation of urinary salts, and I have seen a fairly large calculus deposit in a stricture area two weeks after the last dilatation.

Dr. Stevens mentioned that some of these patients ceased their bleeding after the passage of one plain catheter and wonders whether the good results, which have often been ascribed to the silver nitrate or the adrenalin used to lavage the kidney in such cases, were not really due to the improvement in drainage following the use of the catheter. Undoubtedly he is correct.

We have all had similar experiences with the patient who comes in with a pain in the kidney. We investigate with a plain catheter without bulb and find a kidney of about normal pelvic capacity. *X*-rays are read as negative, and the urine is normal, and we assure the patient there is nothing wrong with the urinary tract. The patient comes back a few weeks later and says he experienced a terrible reaction for a few hours after the investigation, and made up his mind that he would never undergo another similar examination. After a few days, however, his kidney pain was gone, but now for a week or two past it has returned; so he has come in to see whether we will not investigate again, for the first examination certainly resulted in great temporary relief. What better evidence do we need to conclude that the patient had a condition of back pressure in the kidney which

the passage of a plain catheter relieved temporarily?

Dr. Jeck spoke of the man with a typical stone history in whom no evidence of stone could be found. There is not a man in this room or in the world who can differentiate from the patient's history whether the symptoms are due to stone or stricture. Either of these conditions may result in the classical symptoms of colic, bladder and rectal tenesmus, and hematuria, and it is only by accurate urological methods of investigation that we make a diagnosis.

There are many cases on record of patients suffering from kidney colics for many years before a stone was passed or made its way down the ureter to a position where it was found near the bladder. I think Hugh Young recorded one such patient who took twenty-six years to deliver his stone from the kidney to the lower ureter. As a matter of fact, the man had probably been suffering many years from ureteral stricture, and his stone may have formed in the stricture area twenty-six years or only twenty-six weeks or even twenty-six days previously.

REFERENCES

1. ISRAEL, J. Chirurgische Klinic der Nierenkrankheiten. Berl., Hirschwald, 1901, Chap. XIII.
2. STRAUSS, H. Congestive pain and congestive hemorrhage of the kidneys. *Berl. klin. Wchnschr.*, 55: 97, 1918.
3. HUNNER, G. L. Ureteral stricture, an important etiological factor in the so-called essential hematurias. *J. A. M. A.*, 79: 1731, 1922.
4. HINMAN, F., and LEE-BROWN, R. K. Pyelovenous backflow, its relation to pelvic reabsorption, to hydronephrosis and to accidents of pyelography *J. A. M. A.*, 82: 607, 1924.
5. TRAUT, H. F. The mechanism of pyelovenous backflow. *Surg., Gynec. Obst.*, 48: 662, 1929.
6. KOTZENBERG. *Ztschr. f. Urol.*, 2: 125, 1908.
7. KUMMEL. *Med. Klin.*, No. 35, p. 917, 1916.
8. BUMPUS, H. C., JR. Essential hematuria: a clinical study. *J. A. M. A.*, 90: 593, 1928.
9. LIVERMORE, G. R. Causes of renal bleeding. *J. A. M. A.*, 83: 1390, 1924.

GUNSHOT WOUNDS OF THE URINARY BLADDER

REPORT OF TWO CASES*

HAROLD J. SHELLEY, M.D., F.A.C.S.

NEW YORK

THESE cases are reported as they are quite unusual in civil practice and demonstrate the value of roentgenograms with sodium iodide injection in such cases.

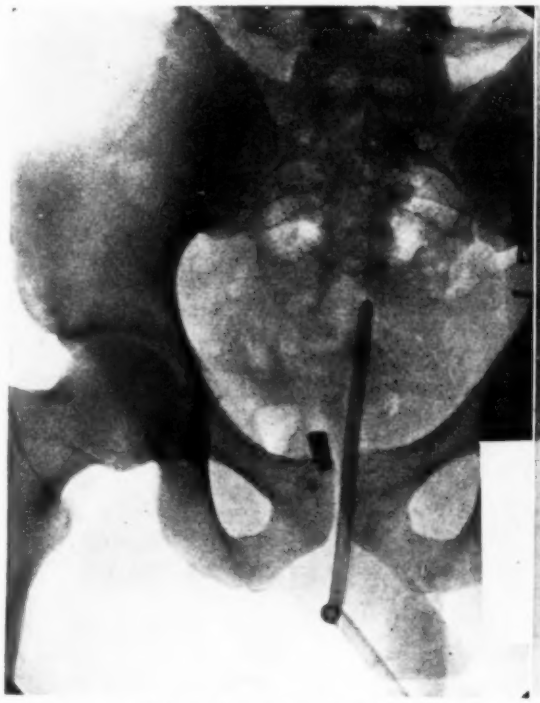


FIG. 1. Case II, with catheter in place in bladder.

FIG. 2. Same after injection of sodium iodide solution into bladder. Note solution outside bladder and depression in bladder wall caused by hemorrhage and extravasated urine.

CASE REPORTS

CASE I. T. C., a bartender, aged forty-one years, was admitted to Knickerbocker Hospital December 31, 1930, because of a gunshot wound in the right side. Two hours before admission he had been involved in a holdup and shot with a 44 caliber automatic steel-jacketed bullet.

The wound of entrance was just below the right anterior superior iliac spine. The bullet could be felt just beneath the skin below the left anterior superior iliac spine. He was unable to void and when catheterized 10 oz. of very bloody urine were obtained.

Examination revealed a moderately obese white man in shock. There was acute tenderness to pressure above the pubis. He was moderately distended although he had had no nausea or vomiting.

Operation was done immediately through a suprapubic midline incision. Two perforations were found in the posterior wall of the bladder just above the entrances of the ureters. Corresponding to these holes were two large holes in the peritoneum. The peritoneal cavity contained a large amount of blood and urine. No bile, gas or other evidence of intestinal perforation could be found.

* From the Surgical Services of Knickerbocker and St. Luke's Hospitals, New York. Submitted for publication April 12, 1931.

The holes in the bladder were closed from the exterior surface. The holes in the peritoneum were likewise closed. A drain was placed down behind the bladder extraperitoneally and the peritoneal cavity was drained at the upper end of the incision.

FIG. 3. One-half hour after Figure 2. No sodium iodide is in evidence in peritoneal cavity and bladder contains larger amount of fluid.

A few hours postoperative the patient developed delirium tremens and notwithstanding a transfusion of 1000 c.c. of whole blood and the administration of whiskey and sedatives he died thirty-six hours after the operation.

CASE II. R. V., a student, aged twenty-one years, was admitted to St. Luke's Hospital, January 1, 1931, because of a bullet wound in the right buttock. He had been shot from behind with a 22 caliber rifle. The bullet was bronze or copper jacketed.

Upon admission he stated that he felt like voiding but was unable to do so. Catheterization obtained several ounces of very bloody urine. He did not appear acutely ill. His respirations were 24, pulse 112 and temperature 100°F. The lower abdomen was moderately tender. The right buttock just lateral to the tip of the coccyx showed a small puncture wound.

Roentgenograms showed a bullet just above the pubis. Injection of the bladder with sodium iodide demonstrated the presence of a perforation on the right side of the bladder. The sodium iodide did not appear to diffuse into the peritoneal cavity.

FIG. 4. Lateral view of Case II, showing bullet in rectus muscle just above pubis.

Operation was done with ether anesthesia. The bullet was removed from the right rectus muscle just above its attachment to the pubis. The bladder wall was exposed and found to have a slit about 2 in. long in its anterolateral aspect. To the right of and behind the bladder the paravesical tissues were badly torn.

The bleeding points were ligated as far back along the track of the bullet as was readily possible. To control the remaining hemorrhage, this part of the wound was packed with iodoform gauze. The hole in the bladder was closed with three rows of chromic sutures and a soft rubber dam drain placed down beside the packing.

Shortly after the operation large amounts of fairly clear urine drained through the urethral catheter and drainage from the wound was very small in amount. The drains and packing were entirely removed by the fifth day and the retention catheter on the eighth.

Further convalescence was uneventful. He has continued to void normally and has had no symptoms of any kind since.

DISCUSSION

It is possible that in the first case there may have been an unsuspected perforation of the intestine although drainage about the rubber dam placed into the peritoneal cavity was only serosanguineous.

The course of the bullet in this case is quite interesting. Starting downward and toward the midline the bullet passed into the peritoneal cavity. The bladder must have been full so that it projected well into the abdominal cavity, and as a result the bullet passed from the peritoneal cavity into the bladder and out again into the peritoneal cavity, through the peritoneum again, striking the pelvic bone, and from there was deflected upward emerging at a point corresponding to the point of entrance on the opposite side.

The path of the bullet in the second case, had it gone in a straight line from the point of entrance to its position above the pubis, would have been through the peritoneal cavity in the pelvis. Instead of that it followed around the wall of the pelvis striking some bony prominence which deflected the bullet upward and medially. It cut the wall of the bladder and struck just behind the pubis from where it glanced upward into the right rectus muscle. The path was in all probability extraperitoneal throughout its entire course.

That the back end of the bullet struck the pubis can be seen by the fact that fragments of lead were left there and only the back of the bullet was not bronze coated.

CAN BENIGN THYROID TUMORS METASTASIZE?

REVIEW OF THE LITERATURE WITH ILLUSTRATIVE CASE REPORT*

MAX THOREK, M.D., AND PHILIP THOREK, M.D.

CHICAGO

THE power of metastasizing at a distance has generally been considered as characteristic of primary malignant tumors. Nevertheless, certain primary benign connective tissue tumors, such as lipomas, myxomas and chondromas, as well as myeloid tumors, are capable of becoming generalized. Benign epithelial tumors rarely generalize, although when one considers the matter, there does not appear to be any sufficiently adequate reason why they should not do so.

FIG. 1. Appearance of patient nineteen years after first operation for tumor of the neck.

Primary adenomas of the thyroid gland apparently form an exception to the general rule of non-metastasization of benign epithelial tumors. Cases of common hyperplastic colloid goiters, giving rise to either benign or malignant metastases in bones, lungs or other tissues are known, although the goiter itself had apparently not undergone any structural change. Indeed, metastatic tumors of pure thyroid tissue structure have been found without any clinical evidence of a primary hyperplasia of the thyroid gland. This fact has given rise to much discussion and controversy and, perhaps, it may be due to the circumstance, as explained by Bérard,[1] that the thyroid more than any other organ, owing to the facility with which

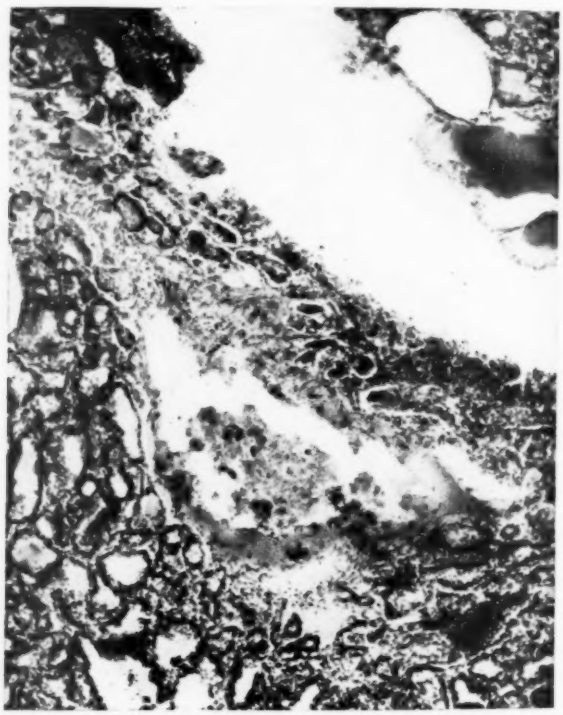


FIG. 2. Structure of thyroid adenoma. Magnified eighty times.

* Submitted for publication June 29, 1931.

one can transplant it and the close relationship of its secretory elements and its blood and lymph channels, is capable of colonizing in other parts of the body.

Cohnheim[2] in 1876, was the first to draw attention to benign metastasizing thyroid tumors. Cohnheim's patient was a woman aged thirty-five, who came to the hospital on account of an abscess in the left sacro-iliac region. No pus was found on opening it, but in the bottom of the cavity there was necrotic bone which, on histologic examination, showed the typical structure of simple thyroid alveoli containing colloid. Necropsy on this patient showed a moderate enlargement of the thyroid which had been overlooked during life but no penetration of the capsule by any new growth, nor any invasion of neighboring tissues. There were two small adenomas in the interior of the thyroid. Metastatic nodules were found in the lungs and bronchial lymph nodes, in the lumbar vertebrae, the sacral and iliac bones, all showing the histologic structure of simple colloid goiter. From this case it was evident that multiple metastatic bone disease may occur from a small simple thyroid adenoma not giving rise to clinical symptoms.

Patel[3] in 1904, collected 18 cases of histologically benign thyroid tumors giving rise to metastases, some of these metastases being benign and some malignant; however, among those classed as malignant were 3 cases of von Eiselberg who, as we shall see later, regarded all such metastases as essentially malignant even if not histologically proved to be so. Bloodgood[4] in 1906, reported that among 25 adenomas of the thyroid, treated at the Johns Hopkins Hospital since 1899, one was seen with metastases to the neck. Wilkens and Hedren[5] in 1909, reported the case of a patient aged seventy-two, with thyroid adenoma and metastases in the cranial and vertebral bones as well as in the iliopsoas muscles. He questions if these metastases were not sarcomatous. Beilby[6] reported that there were in the literature records of about 20 cases of tumors, apparently metastases from the thyroid, which were histologically benign and some of which were considered metastases from normal thyroid tissue. Where a thyroid lesion had been observed it was a simple hypertrophy or adenoma and the metastatic tumor had a similar histologic structure. However, Wegelin[7] in 1926, accepted only 14 of the cases reported in the literature as being histologically proved benign metastases from benign goiters.

From the more recent literature I will cite only the case of Hinterstoisser.[8] His patient, a woman aged forty-six, had a goiter on the right side extirpated to the fullest extent by von Eiselberg because he considered it malignant. She later developed a goiter on the left side for which a partial thyroidectomy was done, and which was proved histologically to be benign. At the age of sixty-eight, she came to the hospital again and was operated upon for a bone tumor of the left thigh, which was histologically shown to be composed of adenomatous thyroid tissue.

Ginsburg[9] who deals only with the bone metastases of thyroid tumors, has scanned the literature of the subject very thoroughly. He cites a number of cases in support of the contention that such bone metastases are of frequent occurrence not only in carcinoma and sarcoma but also in simple adenoma of the thyroid gland; that bulky metastases may arise from even small thyroid adenomas in any stage of development and that even a malignant metastatic tumor may arise from a benign primary adenoma of the thyroid. The metastatic tumor may increase progressively in size while the primary tumor may at the same time recede.

Before considering the clinical aspects of these metastatic lesions a few words may be said in regard to the pathogenic theories and the controversies that have arisen regarding them.

Cohnheim, in accounting for the metastases in his case, considered that the elements of the tumor accidentally penetrated the lymph and blood vessels.

Patel remarks that the colloid goiter is especially that which gives rise to metastases; it is the one which is remarkable for its diffuse cellular proliferation; the cells pass into the capillary circulation, arrive at their destination and develop independently on their own accord either silently, benignly or malignantly.

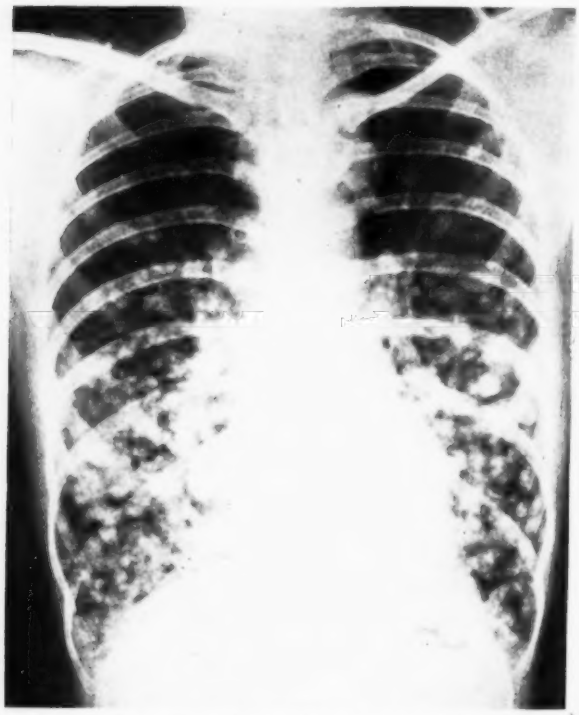


FIG. 3. Chest of patient with metastasizing benign adenoma of thyroid nineteen years after onset of disease.

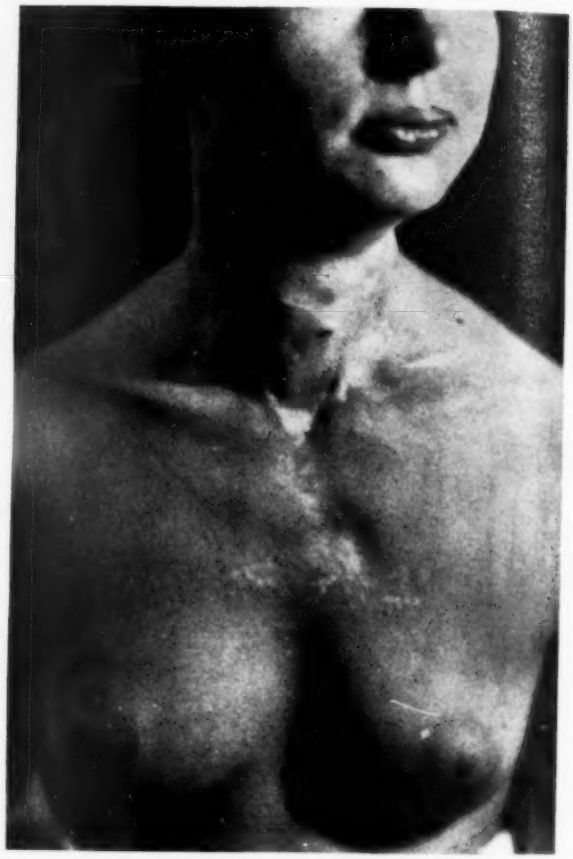


FIG. 4. Patient six months after last operation.

Wolfer[10] whose work on the histogenesis of goiter and thyroid tumors is classic, developed the theory that the thyroid adenoma was only the survival of a fetal adenoma and was a veritable thyroid cancer. He held the view that the goiter which gives origin to metastases ought not to be considered a benign tumor and that the metastatic tumors arising from it, even though histologically not malignant, should be considered as clinically so on account of their growth and destructive action. Von Eiselberg[11] and others also insisted that the occurrence of metastases is proof of essential malignancy, an opinion with which Zadek[12] concurs. He classifies all such primary metastasizing tumors as malignant and gives them the name of adenocarcinoma, even though no true carcinomatous tissue can be found. If not biologically, they are clinically malignant. In Adolf Meyer's[13] case the primary thyroid tumor while adenomatous in one part was apparently undergoing adenocarcinosis in another part, the metastases were benign in some places and adenocarcinomatous in others, the development apparently depending upon the soil in which the cells found themselves.

Ewing considers that metastatic tumors of thyroid tissue may arise from aberrant normal thyroid cells. In connection with them the question of aberrant parathyroid cells may also be mentioned apropos a case reported by Kraft,[14] in which the necropsy on a woman aged sixty, showed a tumor of the left thyroid lobe with metastases in

both lungs and in the pleura and skull, which histologically showed the structure of Langhan's parastruma (parathyroid). The author says that such structures are often found in the thyroid and classed as adenoma.

Another point that might be mentioned here is that the site of a traumatism might act as a *locus minoris resistentiae* in which a metastatic thyroid tumor may appear, as in Brinkmann's[15] case, in which a woman aged forty-five, with no clinically demonstrable thyroid tumor, presented a thyroid tissue tumor at the site of a traumatism in the thigh.

Shapiro[16] in a report recently published, offers a new theory in connection with these cases. In his case there was a benign nodose struma colli with numerous goitrous nodules scattered in the omentum and on the intestinal serosa; ectopic thyroid tissue was also found in the ovary. Shapiro believes that the goitrous nodules in the omentum as well as those in the peritoneal linings, had arisen, not directly from the struma colli, nor as embryonary displacements of thyroid anlage, but as late secondary metastases from the ectopic benign thyroid tissue in the ovary. This would be in accord with Ewing's assertion that metastatic thyroid tissue tumors may arise from aberrant normal thyroid cells.

CLINICAL ASPECTS

From the clinical aspect, metastases from primary benign thyroid tumors are more frequently observed in females than in males. This is probably accounted for by the greater incidence of goiter in the female sex. Of Patel's 18 cases 14 were in females. Zadek gives two-thirds of 60 thyroid metastatic bone tumors as occurring in women; 90 per cent of these are between the ages of thirty and seventy years.

The great tendency is toward bone metastases, the short and flat bones especially being invaded. According to Zadek, 38 per cent of the bone metastases occur in the cranium and 16 per cent in the vertebrae.

Very frequently, owing to the absence of symptoms from the thyroid, the bone metastases are diagnosed as primary sarcoma. From the clinical standpoint the matter would often be of little import, as the tumors have a destructive growth tendency, but in cases where amputation is considered it would be well to investigate the thyroid. It often is apparently quite normal even with extensive metastases, and in any case it is assumed that a histologic biopsy would be made before deciding upon such an important step. If suspected malignancy is not verified an unnecessary amputation might be avoided.

Thyroid metastatic tumors are often sluggish in symptomatology. Such bone tumors do not offer symptoms different from those of other bone tumors. Spinal column metastases may give rise to symptoms of hemiplegia or paraplegia, due either to compression, invasion of the cord tissues or deformity of the column by the growth.

Metastases to the lungs and viscera are much less frequent than to the bones, and in only a few of the reported cases do we find notation of metastases to the lungs. The personal case which I am about to report is rather notable on this account owing to the extensive and diffuse nature of the lung metastases, as seen in the roentgenogram. The ribs and sternum are often involved and Dercum's case (cited by Zadek) is typical of this type.

PROGNOSIS AND TREATMENT

Regarding prognosis and treatment, these metastases are often indolent and may exist for a long time without giving any important symptoms; however, sooner or later they will increase, ulcerate and give rise to hemorrhage and various disturbances, according to their site. They may become important enough to cause cachexia and threaten life. Zadek mentions a metastasis present in the sternum for seventeen years and other cases are recorded of very

long duration. My own case was of very long duration, nineteen years. Metastases to the lung were evidently present in 1915.

Radical surgical removal of metastatic thyroid tumors, if accessible, as well as of the primary adenoma is generally indicated, especially on account of the almost universal and sometimes fatal recurrences. In some of the reported cases extirpation of the metastatic tumor resulted in a permanent cure, but recurrence is the rule.

AUTHORS' CASE

We have recently had under our care a very interesting case of this kind, which we think desirable to report, with the histologic findings. American literature on this subject is rather sparse.

CASE HISTORY

Miss E. D., aged thirty-three, white, entered the American Hospital, Chicago, August 30, 1930, for treatment of a cervical growth.

Family History: Mother living and well; father died of heart disease; two brothers and three sisters are alive and well. Some familial antecedents had symptoms pointing to heart trouble and tuberculosis.

Personal History: The patient's general health had been fairly good. Her childhood was free from the usual diseases. She menstruated at the age of fifteen and had had no menstrual difficulty. At about this time (1912) she first noticed that her neck was swollen. This condition became progressively worse and she entered a New York hospital where she was operated upon. A short time later the adenopathy reappeared, and increased to an enormous size.

Inquiry at the New York hospital elicited the information that the patient was first admitted and operated upon in 1912. A pathologic report dated September 23, 1912, gives the diagnosis of hyperplasia of the thyroid gland (exophthalmic type). In 1913 the patient was readmitted to the hospital and reoperated on for recurrence of the lesion in the neck. The pathologic report of December 1, 1913, shows that there were then three encapsulated masses, all of which on section showed small calcified hemorrhagic cysts. Microscopically there was typical proliferation of the thyroid tissue which in some respects resembled that of exophthalmic goiter. There was no definite evidence of malignancy; the pathologic condition was largely that of adenomatous hyperplasia.

In 1914 recurrence of the growth in the neck led to further operation. On the specimen removed then Dr. Ewing reported as follows:

"The section of tissue from the tumor of the neck of the young girl presents, to my mind, the characteristic structure of a papillary adenoma of the thyroid gland. From your description it appears that the tumor arose from an aberrant portion of thyroid tissue. It is not a very malignant process histologically. Thyroid tumors differ from others in showing much capacity to recur locally and even generalize, while retaining an innocent structure. I should think the case deserves vigorous efforts to remove all accessible tissue."

In 1915 the patient was reoperated upon twice for recurrence. First, in May, with a clinical diagnosis of *angiosarcoma*. The postoperative pathologic report on the removed tumor, however, was:

"Papillary adenoma of the thyroid gland, but places appeared suspicious in nature and suggest probable malignant tendency." The second operation (September 1915) was for *recurring angiosarcoma* of the left thyroid. At that time a roentgenogram showed a *profuse carcinomatous infiltration of both lungs*. The patient was treated medically and discharged unimproved.

Physical Examination: Poorly nourished female with cervical adenitis. *Head*, negative. *Neck*, cervical adenitis of long duration; much cicatricial tissue especially on left side (see Fig. 1). *Lungs, heart, abdomen, urine, and blood were essentially negative.* The Wassermann and Kahn tests were negative.

Clinical Diagnosis: Tumor of neck, probably aberrant thyroid.

Operation: Block anesthesia (novocaine). A 3 in. vertical incision was made over the sternocleidomastoid region; a lemon-sized, extremely vascular growth covered externally with numerous enlarged veins was exposed; its attachments were ligated, sectioned and the tumor removed. An attempt was then made to remove a second small tumor mass situated beneath the left sternoclavicular junction, but because of the extreme vascularity this could not be accomplished. The vessels were ligated and, following hemostasis, the incision was closed. The patient was returned to bed in

good condition. Recovery was without any important incident and she left the hospital on September 30. Her condition has remained good up to the present time and there is no apparent evidence of recurrence at the site of removed tumor. Six months after the last operation the patient had gained 10 lb. in weight and apart from some dyspnea on exertion feels well and is at work (see Fig. 4).

Report of the histologic examination of the removed tumor was as follows: (Dr. J. H. Moore).

"The specimen is an irregular mass 6 × 5 × 3 cm. The surface is smooth with a few small fibrous tags. The cut surface shows a rather definite capsule. The surface is smooth and gray. Many areas are hemorrhagic, others are cystic. There are many calcified areas.

"The microscopic sections show the structure of thyroid adenoma. Some areas are solid with irregular hyperplasia of the epithelium, with many large cells and cells with hyperchromatic nuclei (see Fig. 2).

"In view of the history of a previous thyroid operation, and the location, it is suggested that this may be a recurrence or metastasis, although complete encapsulation indicates a favorable prognosis."

X-ray examination of the chest showed a very extensive and diffuse infiltration of both lungs (see Fig. 3).

Pathologic Diagnosis: From the history of this case and the long duration of the tumor in the neck as well as the roentgen findings of extensive infiltration of the lung in 1915, and from the present histologic and *x*-ray findings it is believed that the condition may be justly diagnosed as so-called benign metastasizing adenoma of the thyroid gland with metastases in the neck and both lungs.

REFERENCES

1. Bérard. Nouveau Traité de Chirurgie (Delbet and Le Dentu), 20: Corps Thyroide, 1908.
2. Cohnheim. Einfacher Gallertkropf mit Metastasen, *Arch. f. path. Anat.*, (Virchows) 68: 547, 1876.
3. Patel. *Rev. de Chir.*, 29: 398, 1904.
4. Bloodgood, J. C. Adenoma of thyroid. *Surg. Gynec. Obst.*, 2: 121, 1906.
5. Wilkens, G. D., and Hedren, G. Metastaserande Sköld-körteladenom, *Hygiea*, 71: 934, 1922.
6. Beilby. Cited by Ginsburg.
7. Wegelin, C. Henke and Lubarsch, Handl. b. spez. Path. (Anat. u. Pathol.). Berlin, Springer, 1926.
8. Hinterstoisser, J. Andenom der Schilddruse mit Knockenmetastase. *Wien, klin. Wchnschr.*, 42: 496, 1929.
9. Ginsburg, S. Bone metastases of thyroid tumors. *Am. J. Roentgenol.*, 17: 203, 1927.
10. Wolfer. Cited by Patel.
11. von Eiselberg. Cited by Patel.
12. Zadek, I. Pathological fracture of neck of femur due to thyroid metastases. *Ann. Surg.*, 77: 689, 1923.
13. Meyer, A. The nature of metastatic tumors of the thyroid. *Worcester State Hosp. Papers*, Baltimore, pp. 95–101, 1912, 1913.
14. Kraft, J. Ein seltener Fall von metastasiernden Parastruma. *Frankfurt, Ztschr. f. Path.*, 37: 481, 1929.
15. Brinkmann, E. Metastasierende Parenchymatöse Struma nodosa in ihrer Beziehung zur Unfallbegutachtung. *Klin. Wchnschr.*, 6: 1903, 1927.
16. Shapiro, P. F. Metastases of thyroid tissue to abdominal organs. *Ann. Surg.*, 92: 1031, 1930.

PROLAPSE OF THE RECTUM

A CONTRIBUTION ON THE ETIOLOGY AND TREATMENT*

SYDNEY D. WEINSTEIN, M.D.

BROOKLYN, NEW YORK

IN order to make a selection of the proper method by which a prolapsed anus and rectum should be operated, to guarantee a successful termination, it is of vital importance that its cause and origin be known. In conjunction with this, other factors must be considered, such as the general condition of the patient, his age, and his ability to withstand operative interference. We will first discuss the etiology of prolapse of the rectum, and then take up a systematic review of the present-day operations, before we enter into a discussion of a case of a patient whom we operated on, that offers an interesting contribution to the cause and treatment of this condition.

While we must assign due significance to the acquired conditions among the causes of prolapse of the rectum, yet it must be remembered that the congenital anatomical abnormalities, especially those of the cul-de-sac of Douglas, of the pelvic floor, and of the suspensory factors of the sigmoid, play the main rôle. This is true even in acquired cases. An abnormally deep-seated cul-de-sac of Douglas will first make its appearance by an invagination of its posterior wall into the rectum, causing a herniation of the anterior wall of the rectum. If that conditions is aggravated by the influence of the normal, and especially by a pathologically increased intra-abdominal pressure, to such a degree that finally the rectum goes through the anus like through the ring of a hernia, then we have before us the picture which Waldeyer has called hernia perinealis medialis. In most cases, this deep-seated cul-de-sac is associated with an absence of the normal curvature of the coccyx and sacrum, which is then more or less straight, so depriving the pelvic floor of a very essential part of its support. There may also be a continuance of the high position of the uterus and bladder, usually found at birth. Furthermore, if there is now present an abnormal weakness of the muscles of the pelvic floor, the resistance of the pelvic diaphragm against the intra-abdominal pressure is diminished to a high degree. If we consider the fact that the sigmoid must be much longer in order that it can reach to the abnormally deep-seated cul-de-sac, then we have all the conditions which can contribute to the formation of a prolapse of the rectum.

In the acquired causes of prolapse of the rectum, we must first mention those conditions which cause a relaxation of the pelvic floor, as all penetrating inflammatory processes of the mucous membrane, as found in a chronic proctitis of any origin; chronic hemorrhoidal afflictions; weakening diseases; neoplasms; injury to the sphincter; and in women, often repeated deliveries, neglected laceration of the perineum and poor repair after hysterectomy. Then there are the nervous diseases which cause a paralysis of the sphincter, as tabes dorsalis, multiple sclerosis, and so forth. Following this, are conditions which cause an increased intra-abdominal pressure, as cases of chronic proctitis associated with frequent tenesmus; chronic constipation; dysentery with diarrhea and tenesmus; stricture of the bowel; nasal obstruction due to adenoids, phimosis; stricture of the urethra; hypertrophy of the prostate; stones in the urinary bladder; chronic bronchitis; whooping cough; excessive vomiting; worms; heavy

*Submitted for publication July 13, 1931.

lifting, etc. Other etiological factors to be considered are poor hygiene, improper diet, and that modern pernicious habit of forcing children to sit on high toilets until their bowels move. Usually, however, several of these etiological factors are present at the same time, and therefore it is of great import to first ascertain the real origin of the prolapse, and upon this finding, base our operative or conservative treatment.

The reduction of the prolapse is best done in the pelvis-high, or the knee-chest positions. The prolapse is softly massaged, using a well oiled piece of linen, at the same time exerting gentle pressure from its apex toward the anus. After the reduction, the patient should be kept in bed for several days. To avoid a recurrence, treat all those conditions which cause a repeated squeezing, namely, chronic constipation, urethral stricture, stones of the urinary bladder, phimosis, etc. It is best that the patient defecate in the lateral position, and that the action of the abdominal pressure be eliminated by giving an oil, or paraffin enema, immediately before dejection. Occasionally, in children, the use of a strap of adhesive plaster across the buttocks, suitable diet, regulation of bowels and general tonic measures, as cod-liver oil, phosphorus, etc., will be successful. At no time, must we neglect to treat, if present, a chronic catarrh of the mucous membrane, a diarrheic condition, hemorrhoids, etc. Perhaps, if there is laxity of the muscles of the pelvic floor and the sphincter, we may attain some fair results, with faradisation, hydrotherapy, massage and gymnastics. All these procedures can be enhanced, especially in children, by subcutaneous or intramuscular injections of strychnine nitrate 0.001, or ergotin 0.1 to 0.2, or phenol. Also, by enemas of equal parts of tannic acid and alum in a 1 per cent solution; or by enemas of adrenalin (30 drops to ½ liter). In some cases, cauterization of the prolapsed mucous membrane with silver nitrate may be tried. If, for all that, the prolapse spontaneously appears again, then one more attempt may be made with one of the numerous bandages recommended by Esmarch, Decker, Bauer, and others.

If we do not attain a good result by these various methods of treatment, if deep ulcers form and produce an increased secretion and continuous pain, if frequent incarcerations with gangrene of the prolapse occur, or even if signs of an intestinal obstruction become apparent, then the operative procedure must be considered as the single successful, or even life-saving treatment. The usual types of operative methods used can be divided into four groups, namely:

1. Methods of narrowing the anus and rectum.
2. Methods of restoration of the pelvic floor.
3. Methods of suspension.
4. Resection of the prolapse.

1. METHODS OF NARROWING THE ANUS AND RECTUM

To narrow the enlarged anus and rectum, one can either cauterize the mucous membrane, or diminish in size the lumen of the anus itself. The pararectal injections of ergotin or alcohol are too uncertain in their effects, and so cannot be recommended. Recently, there have been reports of successful injections of hard paraffin in prolapse of the rectum in children (Kephalinos, Spitzy).

The cauterization can be done either by a corrosive, as nitric acid, or silver nitrate, or by the thermocautery. The mucous membrane is scarified from the apex of the prolapse to within a few millimeters of the anus, in four or five longitudinal strips, going as deep as the muscularis.

When only the swollen and loosened mucous membrane of the anus is prolapsed, the same procedures can be employed as in the operations for hemorrhoids. These are the removal of the folds of mucous membrane by ligature, by excision, or by clamp and cautery. Rotter warmly recommends the procedure de-

scribed by Langenbeck. To prevent afterbleeding, both lips of the wound are joined by a continuous catgut suture. A more simple, but yet as efficacious a method, is the crushing of the mucous membrane by means of a Stillé instrument. When we remove, by one of these methods, three or four folds, and leave between them portions of mucosa of sufficient size, then we need have no fear of stricture formation.

Among the various methods used for narrowing the enlarged anus, the simple wire-ring described by Thiersch (1889), is most worthy of a trial. The many operations used, in which much of the mucous membrane, and even the sphincter is sacrificed, and then sutured (Hey, Dupuytren, Dieffenback, Kehrer, König, Roberts, Lee), should be abandoned.

2. METHODS OF RESTORATION OF THE PELVIC FLOOR

These operations attempt to correct one of the main etiological factors in prolapse of the rectum, namely, relaxation of the musculature of the pelvic floor. As mentioned before, this condition is frequently associated with an abnormally deep-seated cul-de-sac of Douglas, relaxation of the intestinal wall, and increased intra-abdominal pressure.

Two tasks confront us in the plastic repair of the pelvic floor. Firstly, we must reenforce the relaxed muscles and ligaments of the pelvic floor, and secondly, we must narrow the stretched sphincter and rectum. At times, it may also be necessary to combine these operations with a rectopexy or a colopexy. Verneuil, G. Marchant, Lenormand, Hoffman, McCann, and others have described various techniques. A simple procedure has been perfected by Poppert, from whom we quote:

Median incision from the anus to the sacrococcygeal articulation. Retract the subcutaneous fat until the levator ani and the sphincter are exposed. If necessary, do a temporary resection of the coccyx for better exposure. Now, split the levator ani muscle in the midline until its insertion on the anus, thus bringing into view, the posterior wall of the rectum. Insert the left forefinger into the rectum to act as a guide. Now take two sutures vertically through the fascia propria and muscularis of the rectum on both sides of the midline. When these are tied, the posterior wall of the rectum is folded transversely. Do not cut the ends of the sutures, but tie both sides together, thus causing a longitudinal invagination of the rectum, also. In most cases, however, it will be quite sufficient to take two or three transverse sutures, and thus effect a supporting lengthwise fold of the posterior wall of the rectum. At the same time, the lateral walls of the rectum may be fixed to the periosteum of the coccyx, or to the lower border of the sacrococcygeal ligaments. Then the levator ani muscle is sutured in double tier. Finally suture the skin, first inserting a thin rubber drain in the posterior corner of the wound. When the operation is completed, the sphincter and rectum will be found to be narrower, and that the previously thinned pelvic floor will once more form a thick cushion and be distinctly prolongated.

3. METHODS OF SUSPENSION

These operations, rectopexy or colopexy, assay to cure the prolapse forever, by suturing the rectum and sigmoid flexure to its normal position. The simple rectopexy, in which the rectum is fixed to the coccyx, will suffice for the early cases only, but for the obstinate, chronic case, it is not suitable, and shows a 50 per cent recurrence, even when it is modified according to König, who cuts a wedge out of the circumference of the anus. And so, in all these cases, we should combine the rectopexy with the infolding of the intestinal wall, the narrowing of the sphincter, and the restoration of the pelvic floor.

Ekehorn has described a very simple and commendable procedure which is applicable only in children. Under general anesthesia, the prolapse is pushed back, and the left forefinger introduced into the rectum. Then a large aneurysm needle is passed from outside, close to the lower and lateral end of the sacrum into the rectum and brought out through the anus under the guidance of the finger. The needle is

threaded with strong silk and pulled out again. In a similar way, the needle is passed in on the other side of the sacrum, and the other end of the thread pulled out to the back, so that the loop of silk now lies in the rectum. The free ends are pulled up, and tied across the sacrum. The suture is removed after fourteen days. No special after-treatment is necessary. Of course, the question of infection will be raised, but according to Tölken, outside of a slight rise in temperature, no serious complications have been observed.

The final results of the colopexy, as introduced by Jeannel in 1889, are not satisfactory, though it counteracts the hernia-like invagination of the anterior rectal wall, by the fixation of the pelvic colon to the anterior abdominal wall. However, it does not take into consideration the pathological condition of the pelvic floor, and so we find gathered in the literature, reports of more than 50 per cent relapses (Pachnio, Lenormand). This method should be used only as a supplement to the plastic repair of the pelvic floor in severe cases in which the latter operation would not suffice. Mummery reports good results with his operation of tamponade of the retrorectal space. There are others who advocate the passing of sutures around the sacrum, as described by Tuttle. Recently Kümmel has recommended the hitching up of the elongated pelvic colon to the anterior longitudinal ligament of the spine. This method need not be combined with the narrowing of the anus, or with a plastic of the pelvic floor.

In Kümmel's operation, the abdomen is opened by a midline incision, the patient in the pelvis-high position. The rectum is pulled up as high as possible, and fixed to the promontory by three silk sutures which take in 3 cm. of the anterior longitudinal ligament, and then goes through the serosa and muscularis of the rectum at the point of the insertion of the mesocolon. Sudeck has modified this procedure by freeing the rectum in the sacral excavation, then sewing the stretched rectum to the promontory according to Kümmel. He also sutures the lengthwise incision of the peritoneum, in a transverse direction, thereby considerably lifting the bottom of the cul-de-sac of Douglas.

Technique of Colopexy: The patient is in the Trendelenburg position. The abdomen is opened by a 12 to 15 cm. long left rectus incision. If there is difficulty in locating the sigmoid flexure, introduce a thick metal probe into the rectum as high as possible, to bring it into view. Now make traction on the flexure until the prolapse is completely reduced, and the anus retracted. Then the colon is fixed. This can be done to the anterior abdominal wall (Jeannel, Bogdanik, von Eiselsberg) or to the muscles covering the iliac bone, which are denuded of the parietal peritoneum to give a larger and stronger surface for adherence (Rotter, Lenormand, Ball, and others). For that purpose, the retroperitoneal tissue is exposed by a longitudinal incision, or by the excision of an elliptical flap of the parietal peritoneum on the fossa iliaca. The stretched colon is placed on this surface and sutured on both sides to the edges of the peritoneum going through the retroperitoneal tissue too.

4. THE RESECTION OF THE PROLAPSE

This operation is either restricted to the removal of the mucous membrane, or it may consist of total resection of the prolapse.

The resection of the mucous membrane according to Rehn-Delorme, is done in the following manner. The prolapse is pulled down with clamps, and the mucosa thoroughly cleansed. An incision is made around the anus, at the mucocutaneous border, penetrating only the outer layer. The mucous membrane is now cautiously dissected downwards to the apex of the prolapse, in the form of a cylinder, always being certain not to go deeper than the muscularis. Interrupted catgut sutures are now inserted from the edge of the skin,

through the muscularis to the edge of the attached mucous membrane. As these are tied, the dissected mucosa is removed, step by step. In this way, the muscularis is brought up against the external sphincter in the form of a pad, and thus tends to support its action. The muscular pad retracts by degrees, so that the normal contour of the anus is not disturbed. The great advantage of this method over that of total resection, is that the peritoneal cavity is not opened, and the procedure itself is not a very severe one. The postoperative finding is a solid, firm pelvic floor, which meets every physiological demand, and grants a fair amount of immunity against recurrence.

Amputation of the prolapse by cautery, or by the Ekraseur is no longer used and that of ligature (Allingham, Weinlechner) is only rarely done.

The technique of total resection of the prolapse as improved by Mikulicz in 1889, is as follows:

Two deep traction sutures are taken at the apex of the prolapse. Then starting anteriorly, 2 cm. away from the anus, the outer intestinal tube is incised, layer by layer, making sure to catch all bleeding vessels. Then open the peritoneum, reduce any prolapsed intestines if present, and close again. Then incise the anterior part of the inner tube, layer by layer. Now suture both walls together, by a through and through continuous suture, which also acts as a hemostatic suture. Leave the suture ends long, and use as tractors. In the same manner, cut through the posterior half of the prolapse. Here, however, one usually does not find peritoneum any longer, but the mesocolon, with its numerous vessels. These must be caught and ligated before cutting, as they may retract beyond reach. After the entire circumference of the stump has been sutured, the sutureline is covered with an antiseptic powder and the short stump is reduced into the anus.

In some cases of habitual prolapse of the rectum, there may exist such a disproportion between the outer and inner tubes, that an exact suturing is scarcely possible. In such cases, a cleft may be left unsewn in the posterior section of the outer tube and a strip of gauze inserted.

In the after-treatment, it is very important to avoid defecation for about one week. The mortality of the operation is very high (10.9 per cent,[1] Lenormand). The chief dangers are hemorrhage, peritonitis, and the length of the operation. It must also be remembered, that a recurrence is possible, as is a postoperative stricture. Therefore this operation should be used only in desperate cases, when the prolapse is ulcerated to a large degree; when it is gangrenous; or when a neoplasm is the cause of the prolapse.

We wish to present a case, which we feel will be very interesting and instructive.

I. A., Female, thirty-six years of age. For the past nine years patient complained of dyschezia, with prolapse of the rectum during defecation. In the beginning, the prolapse reduced itself spontaneously after defecation, but of late, manual reduction became necessary. Ever since the time the prolapse had ceased reducing itself spontaneously, the patient had noticed mucus and blood in the stools.

Findings: Patient short; large-boned; much adipose tissue; skin pasty; bradyphasia. Patient is very timid and gives the impression of an inferior intellectuality. Right pupil reacts slower than the left. Tremor of the hands. Spastic walk, uterus is anteflexed, freely movable, normal in size, adnexa are negative.

Rectal Examination: Protruding from the anus is a portion of the rectum, 8 cm. long, the mucous membrane of which is dark red, and is covered with numberless petechiae, strips of mucus and spots of pus. The prolapsed rectum can be very easily reduced, as the sphincter is completely paralyzed. For this reason it is impossible to keep the rectum in reduction. The perianal skin shows signs of an eczema, the levator ani muscle shows no power of contractability. The pelvic floor is remarkably thinned.

Diagnosis: Multiple sclerosis. Prolapse of rectum.

Note: The patient insists on operation because she describes the prolapse as a torture

being unable to control either defecation or flatulation.

The etiological factor in this case, was very simple, namely the multiple sclerosis. This caused a weakness of the sphincter, resulting in a complete ineffectiveness. It also undoubtedly aggravated any pre-existing relaxation of the pelvic floor. When the prolapse started, the exposure of the mucous membrane caused a secondary proctitis, with all its concommitant symptoms of diarrhea, tenesmus and increased intra-abdominal pressure. We had a vicious cycle which gradually produced a prolapse of such proportions.

We were then confronted with several problems as to the proper surgical procedure to pursue. We could not remove the underlying etiological factor, the multiple sclerosis, surgically. We could expect just as little from a restoration of the pelvic floor because of the completely atrophic condition of the musculature. Also, the perianal eczema countermanded any major surgical procedure on the perineum. Thus we had to be guided by the peculiarities of the case on hand. First we had to obtain a fixation of the rectum without opening the perineum, to avoid a secondary infection from the eczema, and then we had to narrow the anus and at the same time reinforce the sphincter.

We chose the abdominal rectopexy. On August 23, 1928, under general ether anesthesia, with the patient in Trendelenburg position, the peritoneum was opened by a left pararectus incision 10 cm. long. We were immediately confronted with an abnormally elongated sigmoidcolon. The cul-de-sac of Douglas was also abnormally deep-seated. By pulling up on the pelvic colon, we were able to reduce the prolapsed rectum completely, and while the colon was thus held in a stretched position, the sigmoid was fixed against the promontory by three deep sutures. These same sutures served to elevate the floor of the Douglas cavity about 5 cm. We then had left a long loop of sigmoid, which was reduplicated on itself. Between the two loops we then made an enteroanastomosis, and fixed the entire sling against the parietal peritoneum, by taking several U-shaped sutures which were tied above the aponeurosis of the external oblique. The abdomen was then closed in layers.

For the narrowing of the anus, we used the Thiersch procedure, as modified by Peyer, who used a strip of fascia lata instead of wire. A strip of fascia lata, 16 cm. long and 1 cm. wide was removed from the lateral side of the left thigh. The patient was then put up on the Steinschmitt position and four short incisions were made around the anus, one anteriorly, one posteriorly, and one on each side laterally. With the left forefinger in the anus as a guide, the skin between these incisions was undermined by means of a curved clamp. The strip of fascia was pulled through so that both ends came out through the posterior incision. The fascia was tied over the tip of the forefinger in the anus, and the knot anchored with a catgut suture. The four incisions were then sutured.

The after treatment consisted of a daily dose of one tablespoonful of oleum ricini, to assure a soft defecation. The postoperative course was more or less uneventful. The first dejection took place on the third day and was followed by a marked diarrhea, the patient having ten to twelve stools a day. Notwithstanding this, the narrowed anus held securely, without even showing the slightest prolapse of mucous membrane. On the tenth day after operation, the patient got out of bed and for the first time in many months was able to control her defecation and flatulation. The patient was seen again on the first of October. Digital examination of the rectum revealed a large and distinctly contractable sphincter that just admitted the finger. No sign of vaulting of the anus could be detected even after utmost straining on the part of the patient. She now has two regular movements a day and experiences absolutely no difficulties.

We attributed several factors to this very excellent result to: (1) we were assured

of a large and durable adhesion between the rectum and the sacrum, by fixing the stretched colon to the promontory; (2) the entero-anastomosis, and the anchoring of the sigmoid-sling to the parietal peritoneum also tended to exclude the possibilities of a recurrence; (3) the narrowing of the anus by means of living tissue allowed us to reap all the benefits of the simple Thiersch method without incurring any of its disadvantages.

REFERENCES

1. Bauer, A. Der heutige stand der Behandlung des Rektalprolapses. *Ergebn. d. Chir. u. Orthop.*, 1912, 4: 513–612; Berlin, Springer.
2. Becker. Ein Beitrag zur operativen Behandlung d. Mastdarmprolapses. *Beitr. z. klin. Chir.*, 41: 158–166, 1903.
3. DeLorme, M. Sur le traitement des prolapsus die rectum totaux, par l'excision de la muqueuse rectale ou recto-colique. *Bull. et mém. Soc. de Chir. de Paris*, 26: 499, 1900.
4. Hoffman, C. Zur Pathologie des Prolapsus Ani et Recti und seine operative Behandlung durch Beckenboden-plastik. *Zentrabl. f. Chir.*, 24: 667–669, 1906.
5. Kümmel, H. Zur Operation des hochgradigen mastdarmvorfalles. *Zentralbl. f. Chir.*, 25: 465–469, 1919.
6. Ludloff, K. Zur Pathologie und Therapie des Rektumvorfalles. *Arch. f. klin. Chir.*, 59: 447–457, 1899; 60: 717–811, 1900.
7. Mikulicz, J. Zur operativen Behandlung des Prolapsus recti et coli invaginati. *Arch. f. klin. Chir.*, 38: 74–97, 1889.
8. Moschcowitz, A. V. The pathogenesis, anatomy and cure of prolapse of the rectum. *Surg. Gynec. Obst.*, 15: 7–21, 1912.
9. Lockhart, Mummery, J. P. Diseases of Rectum and Colon. William Wood & Co., N. Y., 1923.
10. Pachnio, F. Dauerresultate Der Kolopexii bei Hochgradigen Rectumprolaps. *Beitr. z. klin. Chir.*, 45: 300–334, 1905.
11. Poppert, P. Operationen am Mastdarm in Bier, Braun, Kümmel. Chirurgische Operation. Leipsig, Johann Ambrosia Barth, 1923, 4: 110.
12. Rotter. Zur Kolopexie bei Prolapsus recti. *Zentralbl. f. Chir.*, 37: 1015, 1903.
13. Schmerz, H. Die operative Behandlung des mastdarmvorfalls mittels Fascienplastik. *Beitr. z. klin. Chir.*, 13: 346–371.
14. Tölken, R. Die Ekehornische Operation des Mastdarm Vorfalls bei Kindern. *Deutsche Med. Wchnschr.*, 15: 427, 1915.
15. Tuttle, J. P. Diseases of Anus, Rectum and Pelvic Colon. N. Y., Appleton & Co., 1903.

INTESTINAL OBSTRUCTION*

S. J. WATERWORTH, M.D.

CLEARFIELD, PA.

E. B., a female aged sixty-seven, was admitted to the Clearfield Memorial Hospital May 4, 1929, complaining of pain in the abdomen with nausea and vomiting. She had had her usual health until two weeks before except that she had noticed that she had been loosing weight slowly for the past two years. Two weeks previous to her admission she began to have slight pain and distress in her lower abdomen. She took castor oil and salts alternately which produced good results but did not relieve the abdominal distress. The purgatives taken five days and three days previous were followed by several loose bowel movements. Two days before castor oil and salts taken again gave her no results. An enema taken the day before came back almost clear. This was followed by more severe pain in the abdomen with nausea and vomiting. She had had no bowel movement for three days. The pain was very severe when she was admitted. She stated that she had had high blood pressure for a long time and that it was taken the day before and was 220/100.

The physical examination revealed the eyes, ears and nose normal, artificial teeth, submerged tonsils, a slight thyroid enlargement, chest normal, heart normal, abdomen rigid and tender without localization, vagina normal for a woman of her age; pelvic bimanual examination was impossible on account of rigidity; rectal examination showed no abnormalities except for a few external hemorrhoids and the rectum collapsed, no gas. The extremities were normal.

The laboratory findings were as follows: Blood count: hemoglobin 79 per cent, red blood cells 3,950,000, white blood cells 9,600, polymorphonuclears 81 per cent, lymphocytes 15 per cent, eosiniphils 3. Blood chemistry: urea-nitrogen 43.43 mg., creatinine 2.5 mg., sugar 176 mg., chlorides 470.5 mg. Kahn test was negative.

Diagnosis: Obstruction of lower bowel, peritonitis.

The patient was operated upon under spinal anesthesia. The findings were as follows: pelvic abscess, pelvic peritonitis from puncture of the sigmoid by a toothpick which was protruding from the perforation, congested appendix. The following was carried out: removal of toothpick, evacuation of pus. At the site of puncture, the walls of the gut were the seat of inflammatory edema and were very friable. It was impossible to suture the appendices epiploicae because they were so edematous and friable and impossible to use in the closure of the perforation; therefore the sigmoid was sutured to the posterior wall of the uterus, using the uterus to stop the leak. In the wound the appendix appeared red, thickened and edematous and was removed for fear of postoperative complications. A Coffey drain was passed on either side of the pelvis, rubber tissue separating the gauze and drainage from the sutured area. Peritoneum was closed loosely around the gauze with chromic catgut sutures. Other structures of the abdominal wall were allowed to remain open, packed with iodoform gauze external to the peritoneum.

Following operation the patient had a rather stormy time with adynamic ileus and pulmonary complications. As the wound had been left open for drainage, time was also required for healing. The patient was discharged from the hospital in eminently satisfactory condition at the end of thirty-five days and has remained well.

This was an unusual case of intestinal obstruction, due to perforation by a toothpick, which was partly caused by the mechanical effect of swelling from edema occluding the lumen and partly by paralytic or adynamic ileus from peritonitis. The patient was extremely ill the case being complicated by more or less generalized peritonitis, pulmonary complications, the age of the patient, sixty-seven; yet, she showed marked resistance and her health is normal for her age two years following operation. Last, but not least, this shows the surgical expediency of not trying to suture friable, edematous, infected gut but the utility and time-saving element of suturing another organ covered with peritoneum over the perforation.

*Submitted for publication July 13, 1931.

APPENDICITIS IN CHILDREN*

JOHN J. KIRSCHENMANN, M. D.

BROOKLYN, N. Y.

THESE are successive cases of patients whom I have operated on at the Norwegian Hospital, Brooklyn, but are not part of our general ward service.

EMBRYOLOGY

The anlage of the cecum buds out as a small evagination on the caudal arm of the embryonic intestine at six weeks of age. At the eighth or ninth week the large intestine increases rapidly in diameter and the cecum is carried across to the right side of the abdomen and comes to lie caudal to the liver.

The transverse, descending and sigmoid colon are recognizable in the third month. After the fourth month the portion to which the cecum is attached grows downward in the right side of the abdominal cavity forming the ascending colon. The cecum increases uniformly in size for a time and then suddenly the proximal end increases more rapidly than the distal end. The distal end remaining slender forms the vermiform appendix.

Structurally the appendix is composed embryologically of two layers, entoderm which lines the lumen and splanchnic mesoderm which borders on the body cavity. From the mesoderm the lymphatic tissue corresponding structurally to the tonsil is developed. The appendix especially is the seat of extensive lymphatic tissue formation.

ETIOLOGY AND PATHOLOGY

From a study of the cases in this report it appears that acute upper respiratory infections in children are the causative agent in appendicitis. Kretz considers the hematogenous infection of the appendix wall by bacteria transported from infected tonsils as the common origin of appendicitis.

W. G. MacCallum states that apparently the streptococcus accompanied by the colon bacillus has been found most often in diseased appendices. Acute upper respiratory infections are quite uncommon in the newborn. In fact they become more prevalent with each year of life. This is true also of the incidence of appendicitis from birth up to twenty years of age. There is a relationship between the occurrence of tonsillar infections and appendicitis. Appendicitis probably is a complication of tonsillitis in the same sense as is rheumatic fever or endocarditis.

During an attack of tonsillitis a hematogenous infection may take place. If it does the intestine having an abundance of lymphatic tissue similar to that in the tonsil and the appendix a proportionately greater amount is prone to pick up the infection. When this occurs a reaction takes place, inflammation. This reaction causes swelling, kinking, obstruction of the lumen, with the resulting appendicitis. If the predominating infection is in the intestine and not in the appendix, the reaction is not sufficient to cause a surgical abdomen and the condition passes as an abdominal grippe. The resulting degree of appendicitis depends upon the severity of the infection and the strain of the infecting organism.

Chronic appendicitis is caused by attacks of less severity in which the mild acute attack subsides producing round cell infiltration, thickening and scarring. Frequently this type is called a bilious attack or an upset stomach by the clinician. When this type comes to operation it is usually the result of a fecalith or stasis producing

*Submitted for publication July 13, 1931.

a pressure necrosis and secondary infection by B. coli. It is usually of the slow, insidious onset in children, but the mother has caused the appendix to perforate by the free use of cathartics.

If the real acute case is operated before suppuration takes place there is free fluid in the abdomen and the appendix is swollen and injected. The pathologists report in this type of case is frequently one of chronic appendicitis. This diagnosis could not be made if a microscopical study was made of the appendix.

INCIDENCE

McCash in 1000 cases of appendicitis reports:

51 patients between five and ten years of age.

17 patients under five; of these 4 were under two years.

Churchman in 1223 cases of appendicitis reports:

50 patients between five and ten years of age.

9 patients under five years.

Curtis Ginn reports 97 cases of appendicitis:

13 patients were between five and ten years of age.

6 patients under five years.

4 of these 19 children died.

SYMPTOMS

Abdominal pain was present in all cases, although in only one case was it severe enough for the child to voluntarily stay in bed. Nausea, unaccompanied by vomiting occurred only in one case. Vomiting occurred in 82 per cent of the cases. Repeated vomiting occurred only in the peritonitis cases. Bowels:

1 child was constipated.

2 had a diarrhea.

6 were given cathartics; 2 were given enemas because of the abdominal pain.

Of the 8 patients with peritonitis, 4 had received cathartics and one an enema. One patient with gangrenous appendicitis had received a cathartic.

Urination frequency was complained of by one child. Upper respiratory infections: 4 patients complained of sore throat, although on examination 13 of the 18 patients in this series were found to have acute upper respiratory infections with sore throat. Fever was present in all cases. It was influenced more by the severity of the infection than the amount of destruction or peritonitis.

DIAGNOSIS

Routine physical examination is necessary to rule out other conditions and to ascertain the condition of the throat, as children rarely complain of pain with tonsillitis. If a child starts vomiting or complains of abdominal pain forty-eight hours after an upper respiratory infection the diagnosis is to be suspected.

The child usually appears too sick for the physical findings.

If the abdomen is rigid with distinct localized tenderness, there is no difficulty in diagnosis providing pneumonia has been ruled out. Usually, however, the abdomen is soft, though the child may hold it spastic. In this type pyelitis must always be considered. In this group of 18 cases only 5 had some degree of rigidity. There is usually some tenderness in the lower right quadrant.

The diagnosis is always made or confirmed by a rectal examination. The finger is gently inserted into the anus until it reaches above the fixed portion of the rectum. The left side of the pelvis is then palpated to determine the normal reaction. The finger is then swept over to the right side and the appendix area palpated. If there is a mass there is no difficulty. The usual findings are extreme tenderness and slight resistance due to the infiltration about the appendix. The tenderness on the left side is then compared with that on the right by bimanual palpation. With this method the right sided tenderness becomes very severe. If this extreme tenderness is illicited a diagnosis of appendicitis should be made. The appendix

is more frequently palpated in the pelvis in the female than in the male.

Blood count is of practically no value, although it is usually increased. A count of 4200 polymorphonuclears was found in one case of general peritonitis and in another case complicated by grippe.

When the diagnosis is made the child should be operated upon immediately whether peritonitis is present or not.

OPERATION

Children stand peritonitis better than adults, but they cannot stand dehydration.

Age	Sex	Abdominal Pain	Condition of Abd.	Tenderness	Rectal Tend.	Temp.	Blood Count	Condition of App.	Days Hosp.
2	M	3 days	Rt. rectus rigid	L.R.Q.	Pres.	103	19,000 89%	Ruptured abscess; peritonitis	21
2½	F	2 days	Soft	L.R.Q.	Pres.	101[6]	none	Ruptured; gen. perit.	died
3	F	1 day	Soft	L.R.Q.	Pres.	103[2]	16,200 91%	Acutely inflamed	15
4	F	1 day	Soft	L.R.Q.	Pres.	101[6]	16,700 90%	Gangrenous; gen. perit.	14
4½	F	22 days	Soft	L.R.Q.	Pres.	101[4]	16,100 87%	Ruptured; gen. perit.	21
4½	M	7 days	Dist.	L.R.Q.	Pres.	101[6]	36,000 90%	Ruptured; gen. perit.	died
5	F	1 day	Soft	L.R.Q.	Pres.	103	12,100 80%	Acutely inflamed	13
6	M	6 hrs.	Board like	L.R.Q.	Pres.	102	11,400 87%	Acutely inflamed	15
6	M	1 day	Rt. rectus rigid	L.R.Q.	Pres.	102[6]	none	Acutely inflamed	10
7	M	1 day	Soft	L.R.Q.	Pres.	102	6,000 70%	Acutely inflamed	12
7	M	1 day	Soft	L.R.Q.	Pres.	104	20,900 87%	Acutely inflamed	13
7	F	2 days	Soft	L.R.Q.	Pres.	102	21,000 91%	Ruptured; pel. perit.	25
8½	M	3 days	Soft	L.R.Q.	Pres.	99	7,800 68%	Acutely inflamed	10
11½	F	1 day	Rt. rectus rigid	L.R.Q.	Pres.	99	none	Gangrenous	16
12	M	1 day	Rt. rectus rigid	L.R.Q.	Pres.	99	4,200 72%	Gangrenous, gen. perit.	40
12	F	1 day	Soft dist.	lower abd.	Pres.	99	23,350 89%	Ruptured; gen. perit.	27
12	F	1 day	Soft	L.R.Q. kidney	Pres.	99[6]	10,550 85%	Acutely inflamed	12
12	M	4 days	Soft	L.R.Q.	Pres.	101[6]	4,200 60%	Acutely inflamed	14

Prior to operation they should be given one or two clyses of saline solution.

A right rectus incision is used in all cases where gangrene, abscess or peritonitis is expected. A McBurney incision is used in acute cases where no complications are expected. Transverse incisions are not used as the resulting scar is too conspicuous. The incision should be small, but ample to give good exposure.

The entire area should be walled off before disturbing the cecum or the appendix.

The appendix should always be removed.

Cigarette drains are used when necessary one being inserted into the pelvis and another at the site of the appendix. Rubber tubes should not be used as the hard surface causes considerable infiltration in the resulting sinus. This delays healing of the sinus after the tube is removed. The Penrose drain is too small to give ample drainage in abscess or peritonitis cases.

Postoperatively 1 or 2 doses of codein are given to allay restlessness. Saline clyses are given freely. Milk, cereal and orange juice are given in small amounts after twelve hours if the child retains sips of warm water. Drains are freed at the end of forty-eight hours and removed as soon as the case warrants.

Ether is the anesthesia of choice. Anesthesias used:

Ether	13 cases
Spinal	1 case
Ethylene	1 case
Nitrous oxide	1 case
Novocaine	2 cases, local infiltration in children four and one-half and seven years old.

CASE REPORTS

The following case histories are given in brief to illustrate some of the types of appendicitis occurring in children.

Case 1. No. 37666. Age twelve. Admitted April 8, 1930.

The child had not felt well for four days. There was no nausea or vomiting, but some abdominal pain. Fever and cough were present.

Diagnosis: Grippe; acute appendicitis.

Physical examination: Tonsils reddened, enlarged. Few râles in chest. Abdomen soft. Slight tenderness over McBurney's point. Very tender on rectal examination. Blood count, 4200; polymorphonuclears 60 per cent, mononuclears 40 per cent.

The diagnosis was confirmed by a consultant.

Operation: Spinal anesthesia, McBurney incision. The appendix was thickened, swollen, injected, covered by lymphatic exudate.

The patient was discharged on the twelfth day as recovered.

Case II. No 39287. Age four and one-half. Admitted August 20, 1930.

The patient was taken ill four days previously with a cold. He had had some fever and cough. The day before admission to the hospital he vomited six times and then had some abdominal pain. The bowels moved three to six times daily; loose, green, mucoid. He received a dose of castor oil.

Physical examination: Tonsils were markedly injected and edematous. Abdomen was soft, and tender in the lower right quadrant; very tender on rectal examination. Blood count, 16,800; polymorphonuclears 87 per cent, mononuclears 13 per cent.

Diagnosis: Grippe and acute appendicitis. The consultant considered case one of grippe only. Case was watched by the consultant and myself.

On August 24 a definite mass was felt and operation was decided upon.

Operation: Ether anesthesia; right rectus incision 2½ inches long. The muscle was edematous, the omentum dull; there was free pus throughout the peritoneal cavity. The appendix was found behind the bladder, perforated. Coils of intestine were about the appendix, acutely angulated and held together by plastic lymph. The abdomen was drained.

Pathological diagnosis: Acute appendicitis.

The patient was discharged on the twenty-first day as recovered.

Case III. No. 39263. Age six. Admitted August 8, 1930.

The patient had had cramp-like pain in the abdomen of six hours' duration. Mother had forced vomiting. The child has had repeated sore throats and a mild attack of appendicitis two years ago.

Physical examination: The abdomen was board like throughout; tender over McBurney's point; very tender on rectal examination. There was no sore throat; chest was negative.

Blood count 11,400; polymorphonuclears 87 per cent, mononuclears 13 per cent.

Diagnosis: Acute appendicitis.

Operation: The appendix was removed through a 2½ inch right rectus incision. Free straw colored fluid was present in the abdomen. The appendix was adherent to the cecum, distal end swollen, engorged, covered with lymph.

Pathological diagnosis: Chronic appendicitis.

The patient was discharged on the fifteenth day as recovered; he had developed an infected wound.

Case IV. No. 38823. Age two. Admitted July 12, 1930.

The child had a fever and sore throat four days previous. On July 9, he complained of pain in the abdomen. On July 10 he was seen by me.

Physical examination showed no abdominal, but considerable rectal tenderness. A positive diagnosis was not made at the time. The child vomited after the rectal examination. When seen again by me on July 12, a diagnosis of acute appendicitis was made.

Physical examination: The throat was red and inflamed. The abdomen was soft and slightly distended; extreme tenderness on rectal examination. Blood count 19,000; polymorphonuclears 89 per cent, mononuclears 11 per cent.

Operation: Ether anesthesia, 2 inch right rectus incision. The appendix was retrocecal, adherent to the cecum. When the adhesions were freed about one ounce of pus was evacuated and a fecalith the size of a pea was found lying alongside a gangrenous, perforated appendix. The stump of the appendix could not be invaginated in this case. Drainage was used.

Pathological diagnosis: Acute appendicitis.

The child was discharged on the twenty-first day, recovered.

MORTALITY

In this series of 18 cases one death was not directly attributable to appendicitis and is not included in the mortality rate. This boy, four and one-half years of age, had pneumonia of the entire right lung and of the left base in addition to a general peritonitis with marked distention when first seen. He was in extremis and operation was performed under local anesthesia in the hope that by drainage of the abdomen some of the toxicity would be relieved. Of the 17 other cases shown in the table:

1 case was of abscess with localized peritonitis
1 case of pelvic peritonitis
6 cases of general peritonitis
8 cases of acute appendicitis
1 case of gangrenous appendicitis.

The other death was in child aged two and one-half who had been sick four days. The tonsils were badly diseased. The appendix was retrocecal, ruptured, with a general peritonitis. The child took ether anesthesia very poorly, the operation having to be stopped while carbon dioxide, oxygen and artificial respiration were given. Immediately after the operation the child's temperature rose to 108°F., and he died on the fourth day of a postoperative pneumonia.

The mortality rate was 5.8 per cent.

CONCLUSIONS

Appendicitis in children is a complication of upper respiratory infections.

Children stand peritonitis very well.

Free use of saline clyses is essential.

Operation should be performed as soon as the diagnosis is made.

The appendix should always be removed.

STRICTURE OF THE RECTUM

WITH SPECIAL REFERENCE TO STRICTURE IN THE COLORED RACE

REPORT OF 160 CASES*

HERBERT T. HAYES, M.D., F.A.C.S.

HOUSTON, TEXAS

THERE have been a great many papers written on stricture of the rectum and the various etiological factors discussed. The problem of stricture of the rectum in the colored race, as it presents itself to me, is somewhat different from that in the white. This has been mentioned by several men who live where there is a large negro population, notable contributions having been made by Day[5] and Rosser.[17] To Rosser, we are indebted for advancing the theory or fact that the tissue of the negro is different from that of the white and that they have a marked scar-forming tendency, which he terms a "fibroplastic diathesis." I do not doubt that this is the basis of stricture formation in the colored race, and all that is needed for an excess of fibrous tissue to form is for them to have an injury of some kind. Whether this be traumatism or bacterial invasion with ulceration makes no difference. We see strictures of the urethra in the colored men more than in any other race, but strictures of the rectum occur much more frequently in the colored women.

I believe that we have bacterial invasions of the rectum in the white and Mexican races almost as frequently as we do in the colored, but there is not that marked tendency to scar formation in these two races as there is in the colored. Two years ago,[9] I brought to the attention of the profession the fact that there is a marked frequency of gonorrhea of the rectum in both white and colored. In fact, I believe that gonorrhea of the rectum occurs in 35 per cent or more of all females who have a gonorrheal vaginitis.

I am discussing in this paper 160 cases of stricture of the rectum which have come under my observation. These cases have come from my own clinics at the Jefferson Davis Hospital and the Hermann Hospital, my private practice, and from the clinics of Dr. Hugh C. Welsh at these hospitals. I have made a number of comparative charts in order to get more accurate data on the number of rectal cases compared with all admissions to the clinic, then the percentage of stricture cases, together with the race percentage and the sex percentage. We have Wassermann tests and smears wherever possible, but in a number of the first cases seen, we did not have either Wassermann tests or smears.

From Table 1, you will note that we had over 34,000 white patients, over 42,000 colored, and over 14,000 Mexicans, a total of 91,446 cases. There were 2747 rectal cases from this number, 1970 of which were white, 726 colored, and 51 Mexicans. You will note there was a marked difference in the proportion of rectal cases in the colored as compared with the Mexicans. There were more white males than white females, but more colored females than colored males. The total sex percentage of all races combined was about the same. We would probably have had more admissions of the colored to the various hospitals if we had had the accommodations. We were never able to admit as many of these patients as we should, because of the lack of beds. In private practice, I rarely ever see a colored patient; therefore, cases seen in my private practice represent people that we meet in the ordinary walks of life.

* Submitted for publication September 22, 1931.

In Table II, there were only 113 rectal strictures for comparison, as there were 47 cases of stricture listed prior to 1928

In Table III, which is a study of the series of 160 cases, the males constitute 15.82 per cent of the whole and the females

TABLE I

TOTAL NUMBER OF CASES AND NUMBER AND PERCENTAGE OF RECTAL CASES FROM HERMANN HOSPITAL, JEFFERSON DAVIS HOSPITAL, AND PRIVATE PRACTICE

Origin of Material	Number of Cases	Race	Race Per Cent of Cases	Number and Per Cent of Rectal Cases	Race Per Cent of Rectal Cases	Sex Per Cent of Rectal Cases Race Segregated		Total Sex Per Cent of Rectal Cases	
						Male	Female	Male	Female
Hermann Hospital Clinic 1926, 1927, 1928, 1929, 1930	12,455	White	8818 or 70.79	357 or 3.89	196 or 54.9	73 or 20.44	123 or 34.45	114 or 31.92	243 or 68.08
		Colored	3637 or 29.20		161 or 45.09	41 or 11.48	120 or 33.61		
Jefferson Davis Hospital Clinic 1928, 1929, 1930	75,630	White	22,662 or 29.98	939 or 1.24	342 or 36.42	229 or 24.38	113 or 12.03	441 or 46.96	498 or 53.03
		Colored	38,397 or 50.76		546 or 58.14	184 or 19.59	362 or 38.55		
		Mexican	14,571 or 19.27		51 or 5.43	28 or 2.98	23 or 2.44		
Private Practice 1927, 1928, 1929, 1930	3361	White	3308 or 98.42	1451 or 43.17	1432 or 91.79	833 or 57.40	599 or 41.28	842 or 58.02	609 or 41.97
		Colored	53 or 1.57		19 or 1.3	9 or .62	10 or .68		
Total	91,446	White	34,788 or 38.04	2747 or 3.0	1970 or 71.71	1135 or 41.31	835 or 30.39	1397 or 50.85	1350 or 49.14
		Colored	42,087 or 46.02		726 or 26.42	234 or 8.51	492 or 17.91		
		Mexican	14,571 or 15.93		51 or 1.88	28 or 1.37	23 or .83		

on which we were unable to get the comparison of the number of cases seen and the rectal cases. You note the rather marked difference in the percentage of stricture cases in the charity clinics and in private practice. In Hermann Hospital there was 12.6 per cent of the rectal cases that had strictures, in Jefferson Davis Hospital, 5.32 per cent, and in private practice, 1.25 per cent; a total of 4.11 per cent of rectal cases that had strictures. Of these 113 stricture cases, 21 were white, 90 colored, and 2 were Mexicans. You can see that of all the colored, only nine were males and eighty-one were females. Therefore, of this series of strictures, 72 per cent were colored females. Of the total sex percentage, 19 or 16.81 per cent were male, and 94 or 83.18 per cent were female. 84.17 per cent. In the race chart there was 16 per cent white, 80 per cent colored, and 3 per cent Mexicans. In the chart showing segregation of race and sex the occurrence of stricture in the white male and colored male was about the same, but in the white female and colored female there was a marked discrepancy. There were only 12 white females against 116 colored females, yet the number of white females seen against colored was 2 to 1. The occurrence of stricture in the Mexican male and female seems to be lower than either the white or colored.

The study of the ages of these cases is interesting. The 2 cases between one month and one year old were congenital. Most of the cases of stricture occurred between the ages of twenty-one and thirty years,

there being 66 in this period, and 53 between the ages of thirty-one and forty years. We find more cases between these ages, because this is the most active age sexually and more venereal diseases are contracted at this time than any other.

I believe that in some cases of stricture of the rectum fistulae, rectal abscesses, fissures, and such pathology are the etiological factors. Infection passes up the lymph channels or invades the mucosa and submucosa, with resulting inflammation. I feel reasonably sure that in two of the cases I had, this was the cause of the stricture. Tuberculosis has been assigned very frequently as the cause and congenital strictures occur occasionally. Malignant strictures will not be considered in this discussion. I will take up the classification of the 160 strictures of the rectum in a study of the pathology. This will also give some more details on etiology.

A study of Table IV giving the percentage of smears is quite interesting. Of the 78 smears made, 54 or 69.23 per cent were positive and 24 or 30.76 per cent were negative. There were 82 cases on which no smears were made. In the subchart showing the analysis of these 78 smears, you can see what a high percentage of positive reactions the females had, especially the colored females. In making these tests, one should not be satisfied with one negative smear but should make repeated smears, because the mixed bacterial flora often obscures the gonococci and I think that very often this mixed flora kills out the gonococci and you have only the mixed bacteria left.

In Table V, we have an analysis of Wassermann reactions. There were 103

TABLE II

PERCENTAGE OF RECTAL CASES, PERCENTAGE OF STRICTURE CASES, RACE PERCENTAGE, AND SEX PERCENTAGE, 113 CASES OF STRICTURE OF THE RECTUM

Note: 47 Cases of Stricture from Jefferson Davis Hospital Prior to 1928 Not Given in This Chart

Origin of Material	Number of Rectal Cases	Race	Race Per Cent of Rectal Cases	Number and Per Cent of Stricture Cases	Race Per Cent of Stricture Cases	Sex Per Cent of Stricture Cases Race Segregated		Total Sex Per Cent of Stricture Cases	
						Male	Female	Male	Female
Hermann Hospital Clinic 1926, 1927, 1928, 1929, 1930	357	White	196 or 54.9	45 or 12.60	6 or 13.33	1 or 2.22	5 or 11.11	3 or 6.66	42 or 93.33
		Colored	161 or 45.09		39 or 86.66	2 or 4.44	37 or 82.22		
Jefferson Davis Hospital Clinic 1928, 1929, 1930	939	White	342 or 36.42	50 or 5.32	2 or 4	1 or 2	1 or 2	7 or 14	43 or 86
		Colored	546 or 58.14		46 or 92	5 or 10	41 or 82		
		Mexican	51 or 5.43		2 or 4	1 or 2	1 or 2		
Private Practice 1927, 1928, 1929, 1930	1451	White	1432 or 91.79	18 or 1.25	13 or 72.22	7 or 38.88	6 or 33.33	9 or 50	9 or 50
		Colored	19 or 1.30		5 or 27.77	2 or 11.11	3 or 16.66		
Total	2747	White	1970 or 71.71	113 or 4.11	21 or 18.58	9 or 7.96	12 or 10.61	19 or 16.81	94 or 83.18
		Colored	726 or 26.42		90 or 79.64	9 or 7.96	81 or 71.68		
		Mexican	51 or 1.88		2 or 1.76	1 or .88	1 or .88		

Wassermann tests made, with 71 or 68.93 per cent positive, and 32 or 31.06 per cent negative. The remaining 57 had no Wassermann tests taken. The proportion of positive Wassermann tests in the races seems to be about the same, and about the same in both male and female, yet there is no increase in the number of strictures in the colored male because of this. Syphilis might play some part in the formation of stricture, but it would seem to me from the study of the smear and Wassermann charts on these cases that there is evidently some other factor much more important than syphilis, and I believe that this is gonorrhea. Negro men have syphilis about as often as negro women and if syphilis were the chief

TABLE III

SEX

	(Per Cent)
Male	25 (15.82)
Female	133 (84.17)
Not given	2

RACE

	(Per Cent)
White	25 (16.02)
Colored	126 (80.77)
Mexican	5 (3.20)
Not given	4

160 CASES

Sex	White (Per Cent)	Colored (Per Cent)	Mexican (Per Cent)	Race Not Given (Per Cent)
Male	13 (8.12)	10 (6.25)	1 (.62)	1 (.62)
Female	12 (7.50)	116 (72.50)	4 (2.50)	1 (.62)
Sex not given	.....	.....	.....	2 (1.25)
Total	25 (15.62)	126 (78.75)	5 (3.12)	4 (2.50)

AGE INCIDENCE

1 mo. to 1 yr.	2
1 yr. to 10 yrs.	0
11 yrs. to 20 yrs.	2
21 yrs. to 30 yrs.	66
31 yrs. to 40 yrs.	53
41 yrs. to 50 yrs.	12
51 yrs. to 60 yrs.	7
61 yrs. to 70 yrs.	6
71 yrs. to 80 yrs.	1
Not given	11

etiological factor, it seems that the negro men would have strictures as often as the negro women. Twenty-nine of these the smears which anyone who is interested can study at his leisure.

Symptoms of stricture of the rectum

TABLE IV

SMEAR

	(Per Cent)
Positive	54 (69.23)
Negative	24 (30.76)
Not taken	82

ANALYSIS OF 78 SMEARS MADE

Race	Male		Female		Total	
	Positive (Per Cent)	Negative (Per Cent)	Positive (Per Cent)	Negative (Per Cent)	Positive (Per Cent)	Negative (Per Cent)
White	2 (2.56)	1 (1.28)	3 (3.84)	2 (2.56)	5 (6.41)	3 (3.84)
Colored	1 (1.28)	3 (3.84)	47 (60.25)	16 (20.51)	48 (61.53)	19 (24.35)
Mexican	.....	1 (1.28)	1 (1.28)	1 (1.28)	1 (1.28)	2 (2.56)
Total	3 (3.84)	5 (6.41)	51 (65.38)	19 (24.35)	54 (69.23)	24 (30.76)

TABLE V

WASSERMANN TEST

	(Per Cent)
Positive	71 (68.93)
Negative	32 (31.06)
Not taken	57

ANALYSIS OF 103 WASSERMANN TESTS MADE

Race	Male		Female		Total	
	Positive (Per Cent)	Negative (Per Cent)	Positive (Per Cent)	Negative (Per Cent)	Positive (Per Cent)	Negative (Per Cent)
White	4 (3.88)	2 (1.94)	3 (2.91)	3 (2.91)	7 (6.79)	5 (4.85)
Colored	4 (3.88)	3 (2.91)	58 (56.31)	23 (22.33)	62 (60.19)	26 (25.24)
Mexican	1 (.97)	.....	1 (.97)	1 (.97)	2 (1.94)	1 (.97)
Total	9 (8.73)	5 (4.85)	62 (60.19)	27 (26.21)	71 (68.93)	32 (31.06)

cases had positive Wassermann reactions and positive smears. I have a chart on the comparison of the Wassermann tests and

are straining at stool, passing of pus and blood, and marked constipation or incontinence, many not being able to have a

stool without taking medicine to make it liquid. The incontinence is from the fact that you have a tube-like stricture which probably involves the anal canal and there is no contractility left in the anal muscles. There is frequently a great deal of pain from fissures or ulcers in the anal canal. If the condition has been present for a long time, there are the accompanying symptoms of obstruction, such as the formation of large amounts of gas, colic-like pains in the abdomen, and indigestion.

The diagnosis is easily made by proctoscopic examination, digital examination, or *x*-ray. It is not often necessary to do a biopsy. A study of the pathology in this condition is not very illuminating as to the cause of the stricture. The following is a typical pathological report from a section of tissue examined: "Section from rectum with markedly thickened walls, showing hard fibrous tissue formation throughout. There is rather marked round cell infiltration. Mucous membrane is absent. Diagnosis: Inflammatory stricture of the rectum." I have had many sections examined, but the pathologists have never been able to give any definite information on the etiological factor. They were not able to tell whether the tissue was leutic or not and they have never given me a report stating that it was tuberculous.

In the classification in Table VI of the 160 cases, I have reported 147 cases of inflammatory stricture and have not included tuberculosis in these. I did not classify syphilitic strictures as a separate type of stricture, because I do not believe that syphilis plays a very important part in the causation; I think it is more coincidental rather than causative. Under these inflammatory strictures, you will note again the preponderance of the occurrence of strictures in the female colored, and under the concentrated chart marked "Smears for Gonorrhea" that in the 74 cases on which there were no smears, there was a history of pelvic infection in 33.

I have listed 3 cases as tuberculous, but am not certain that they were tuberculous, because I did not find tubercle bacilli and could not tell from the tissue involved. However, these 3 cases had a persistent diarrhea of almost nothing but pus and blood and one had many constrictions throughout the bowel, which we felt were tuberculous.

Of the 6 postoperative strictures, 5 were in white people and 1 was in a colored male. I have put in this list, 1 case that might have been classed as inflammatory. This particular case was the result of injection treatment for hemorrhoids and is the only case of stricture of the rectum that I have ever seen following this mode of treatment. I did not give the patient the injections, but saw him after the stricture had begun to form and communicated with this former doctor, who told me that the patient did not have a stricture when he first started treatment.

Two cases were congenital strictures, one being in a male infant and the other in a female infant. These children were born with openings that would only admit a probe to the anus.

There was 1 case of perirectal stricture in a colored man, resulting from a periprostatic abscess which circled the rectum. The rectal mucosa was not involved. I believe that this type of stricture is extremely rare. I had the privilege of seeing this man when he had the periprostatic abscess and watched this condition form. The pus almost circled the rectum and formed fistulae in the perineum.

There was one case of true spasmodic stricture in a white male, a young man who had a small anal fistula which passed up the mucosa of the rectum. He had a great deal of pain in the sacral region. The spasmodic stricture was about 3 in. up the rectum and had been present so long that a great deal of fibrous tissue had formed. After the fistula had been dissected up to this spasmodic structure and followed by a year's treatment of massage

and frequent rectal lavages, this stricture gradually gave way.

Some men have suggested that strictures are caused by chronic pelvic inflammation with infiltration of the perirectal lymphatics. I believe that this is very rare and that the development begins in the mucosa of the rectum, with ulceration and infection, and scar formation in the mucosa and submucosa finally involving the entire wall of the rectum and some of the perirectal tissues. I do not believe it is necessary to classify these strictures as annular or tubular, because with the exception of some of the anal strictures resulting from operations, most of the rectal strictures become tubular in time. They usually have an annular ring at some place in the canal, but there will develop a tubular stricture above or below this ring as time goes on. This ring might form at the levator margin or at one of the rectal valves, but it is only part of the general strictured condition of the rectum.

I have noted that in the cases of stricture in the negro women there is nearly always an active ulcerating process present, with condylomata in some parts of the anal canal and especially where there is an annular ring. Very frequently there is a rectovaginal fistula. I do not have a list of the cases in which this has occurred, but it is extremely frequent. It seems that you would get a fistulous tract above the stricture, but such is rarely the case. Most of the fistulous tracts occur below the annular ring, and when one is present, it usually passes through the perineal body. This must be because of the spasmodic contraction of the anal muscles, and the retention of infected material between the annular ring and these muscles.

Complications of these strictures are abscesses, fistulae, upper intestinal troubles, loss of weight, and what might also be mentioned, a persistent infection in the rectum. There are so many pockets that at times it seems almost impossible to rid the rectum of infection. I have seen rheumatism in several cases and had one

TABLE VI

160 CASES OF STRICTURE OF THE RECTUM

Classification	No. of Cases	Race and Sex										Wassermann Test			Smears for Gonorrhea				Treatment						
		White		Colored		Mexican		Not Given							Negative										
		Male	Female	Male	Female	Male	Female	Male	Female	Not Given	Positive	Negative	Not Taken	Positive	Hist. of G. C.	No Hist. of G. C.	History of Pelvic Infection	No History of Pelvic Infection	Colostomy	Excision	Proctotomy and Incision	Dilatation	Local Treatment	Fistulectomy Fissurectomy Hemorrhoidectomy Plastic on Rectum, Etc.
Inflammatory (except tuberculous)	147	8	7	8	115	1	4	1	1	2	69	29	49	53	9	11	33	41	29	4	24	16	69	5
Tuberculous	3	1	1	..	1	..	..	..	..	..	1	1	1	..	..	2	..	1	1	..	..	..	2	
Postoperative	6	2	3	1	....	..	..	..	..	..	..	2	4	1	1	..	..	4	1	..	1	1	3	
Congenital	2	1	1	..	....	..	..	..	..	..	1	..	1	..	..	..	..	2	..	..	..	..	..	2
Perirectal	1	..	..	1	....	..	..	..	..	..	..	..	1	..	1	..	..	..	..	..	..	..	1	
Spasmodic	1	1	..	..	....	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..	..	..	..	1
Total	160	13	12	10	116	1	4	1	1	2	71	32	57	54	11	13	33	49	31	4	25	17	75	8

TABLE VII

COMPARISON OF WASSERMANN REACTIONS AND SMEARS

Race	Sex	Positive Wassermann Reaction with Positive Smear	Negative Wassermann Reaction with Positive Smear	Wassermann Not Taken with Positive Smear	Positive Wassermann Reaction with Negative Smear		Negative Wassermann Reaction with Negative Smear		Wassermann Reaction Not Taken with Negative Smear		Positive Wassermann Reaction with No Smear		Negative Wassermann Reaction with No Smear		No Wassermann Reaction with No Smear	
					History Indicative of Gonorrheal Infection	No History Indicative of Gonorrheal Infection	History Indicative of Gonorrheal Infection	No History Indicative of Gonorrheal Infection	History Indicative of Gonorrheal Infection	No History Indicative of Gonorrheal Infection	History Indicative of Gonorrheal Infection	No History Indicative of Gonorrheal Infection	History Indicative of Gonorrheal Infection	No History Indicative of Gonorrheal Infection	History Indicative of Gonorrheal Infection	No History Indicative of Gonorrheal Infection
White	Male	1	..	1	..	1	..	..	..	..	1	1	..	2	1	5
	Female	1	1	1	..	..	1	..	..	1	..	2	..	1	..	4
Colored	Male	1	..	..	..	..	1	..	2	..	2	1	1	1	..	1
	Female	26	11	10	5	6	1	4	..	..	11	10	4	3	12	13
Mexican	Male	..	..	..	1											
	Female	..	1	..	..	1	..	..	..	..	..	..	..	..	1	1
Not Given	Male	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	Female	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	Not Given	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2
Total	.....	29	13	12	6	8	3	4	2	1	14	14	5	7	14	28

case in which it was so bad that I did an excision. The patient was relieved of the rheumatism, but still had an infection of gonorrhea in the rectal stump.

The treatment of stricture of the rectum, in my hands, has been very unsatisfactory. If these cases are not an emergency when they are seen in the clinic, they are routinely given some kind of an antiseptic with which to irrigate their rectum and the stricture is dilated with the finger if possible. This manner of treatment is maintained as long as possible, in order to help clear up the infection. I do not remember having seen a single case in the clinics that did not have a great deal of infection; however, in private practice, I have seen several that would have been classed as clean cases and these were in white people. If the stricture is so severe that the straining and passing of pus and blood are very marked, we send them into the hospital and under a spinal anesthetic, dilate or incise the stricture. If it is close enough to the anal margin, we do a proctotomy. I have done a proctotomy and incision in 25 cases and simple manual dilation under anesthesia in 17. We then have the patients keep up the rectal irrigations and continue coming to the clinic for dilations.

Clemons[4] recommends the use of carbon dioxide snow and other men have recommended the use of diathermy. I have never used diathermy and have used carbon dioxide on only 1 case. This was a white male with a clean stricture and I believe the result was very beneficial. Unfortunately, it takes a great deal of time to administer these treatments. Clemons does not recommend the use of carbon dioxide where there is a great deal of infection in the rectum and it seems almost impossible to clear up the infection in these inflammatory conditions.

Irrigations, dilations, and a proctotomy will often tide these patients along for several years, but in many we have to do a colostomy. Of this series reported there were 31 colostomies performed. After this is done, the patient can irrigate the bowel from above, down, and this usually gets rid of a great deal of infection. However, we have seemingly never been able to get the bowel entirely free of infection. I had some trouble with the retraction of the colostomy wound in a number of the first patients who were operated upon. This was because of the weak musculature of the abdominal wall, especially in women who had had several babies. Hence, I have adopted the type of colostomy in these particular cases in which all layers are sewed through a large rent in the mesentery under the loop of bowel, and the bowel is not severed entirely when it is opened. This prevents the bowel from retracting and keeps an absolutely clean wound after the operation, as cathartics can be given several times and the bowels cleaned out, and it is not necessary to open the colostomy for eight or ten days. I believe that in the future, I shall resort to excision after the colostomy more often, if the condition of the patient warrants. I think it will be warranted in those cases where the general condition of the patient continues to be bad and the absorption of infection from the diseased bowel seems to be the cause.

It seems to me that excision of the rectum is not resorted to soon enough in these cases. I have done excisions in 4 cases after a colostomy had been performed. In one of these, there was a great deal of infection, with much pus and the patient did not improve as she should have done after the colostomy was performed. In another, rheumatism was very bad. Three of these patients improved markedly after the rectum was removed, but in one, a negro woman who had active gonorrhea, tertiary syphilis, and pulmonary tuberculosis, there was no improvement. Her tuberculosis developed several months after the excision and she died in about one year after the operation.

It is gratifying to see how the general condition of these patients improves after a colostomy. However, many refuse a

colostomy and hence, we lose sight of them. I have had only 1 case in which I was able to close the colostomy. This was a negro woman about fifty years old, whose colostomy we closed after the rectum had become fairly clean and in good condition under irrigations and manual dilations. She has been doing well for about three years. In those patients having syphilis, antiluetic treatment did not stop the development of the stricture or improve the condition in any way. I think, however, it does improve the general health of the patient.

CONCLUSION

I would conclude from the study of these cases that nearly all strictures of the rectum are inflammatory; that gonorrhea, in the colored race at least, is the chief etiological factor; and that they occur much more frequently in colored women than in any other race or sex.

I believe that the scar-forming tendency of the colored race is the real basis of the stricture formation in this race.

There is only a slight tendency to stricture formation in the white and Mexican races.

Syphilis seems to play a very unimportant part in the formation of stricture of the rectum.

As yet, treatment is very unsatisfactory and we feel that excision should be resorted to in the badly infected cases more often than it is at present.

BIBLIOGRAPHY

1. Ashhurst, A. P. C. Stricture of rectum; resection. *Surg. Clin. North America*, 2: 63, 1922.
2. Barbilian, N. Quelques considerations sur le traitment des retrecissements inflammatories du rectum. *Presse méd.*, 33: 286, 1925.
3. Birt, E. Gutartige Strikturen des Rektums. *Arch. f. Schiffs-u. Tropen-Hyg.*, 33: 1, 1929.
4. Clemons, E. J. (a) Rectal stricture and rectal cancer treated with carbon dioxide snow. *Med. Rec.*, 101: 364, 1922.
   (b) An original treatment for rectal stricture. *Tr. Am. Proct. Soc.*, 81: 82, 1924.
   (c) Rectal stricture; a method of treatment with demonstration. *Tr. Am. Proct. Soc.*, 1926.
5. Day, G. H. Urological idiosyncrasies of the negro. *J. Urol.*, 5: 19, 1921.
6. Deroche, J. Contribution a l'étude des retrecissements inflammatoires du rectum. Paris Thesis, 1925, vol. 18.
7. Desplas, B., and Savignac, R. Un cas d'amputation du rectum pour stenose dite inflammatoire. *Arch. d. mal. de l'app. digestif.*, 17: 432, 1927.
8. Gorash, B. A. Gonorrhea of rectum. *Brit. J. Ven. Dis.*, 4: 74, 1928.
9. Hayes, H. T. Gonorrhea of the anus and rectum; report of seventy-five cases. *J. A. M. A.*, 93: 1878–1880, 1929.
10. Heitz-Boyer, M. Retrecissements et polypes du rectum traité par la haute frequence. *Bull. et mem. Soc. de chir. de Paris*, 48: 1045, 1922.
11. Joachimovitz, R. Rectumstrikturen bei gynakologischen Erkrankungen. *Deutsche Ztschr. f. Chir.*, 208: 263, 1928.
12. Kummer, R. H. Le traitement du retrecissement du rectum par la diathermie. *Schweiz. med. Wchnschr.*, 58: 643, 1928.
13. Levy, A. Traitement des retrecissements inflammatoires du rectum par la diathermie. Paris Thesis, 1926, vol. 46.
14. Minor, W. E. Clinical Proctology. St. Louis, Mosby, 1929.
15. Pappo, I. H. A propos d'une brulure du rectum; le traitement diathermique des retrecissements du rectum. Paris Thesis, 1927, vol. 53.
16. Parnell, R. J. G. Venereal lesions of the rectum and anus. *J. Roy. Nav. Med. Serv.*, 15: 77, 1929.
17. Rosser, C. (a) Proctologic peculiarities of the negro; the fibroplastic diathesis. Am. J. Surg., 37: 265, 1923.
   (b) Stricture of the rectum. *Texas State J. Med.*, 9: 508, 1924.
   (c) Rectal pathology in the negro; incidence and peculiarities. *J. A. M. A.*, 84–93: 96, 1925.
   (d) Clinical variations in negro proctology; the venereal factor. Sec. on Gastro-Enterology and Proctology, *A. M. A.*, April, 1926.
18. Savignac, R. A propos des rectites chroniques hypertrophiques et stenosantes. *Arch. d. mal de l'app. digest.*, 15: 269, 1925.
19. Smital, W. Beitrag zur Klinik der entzundlichen Rektalerkrankungen und ihrer Folgeerscheinungen. *Deutsch. Ztschr. f. Chir.*, 170: 318, 1922.
20. Smith, D. New treatment for rectal stricture. *California & West. Med.*, 24: 782, 1926.
21. Vignal, W. La diathermotherapie des retrecissements inglammatoires et cicatriciels du rectum. *Bull. et mem. Soc. de chir. de Paris*, 20: 14, 1928.

NEW INSTRUMENTS

AN IMPROVED HEMOSTATIC FORCEPS*

ROBERT L. PAYNE, M.D.

NORFOLK, VA.

IN the same sense that a chain is no stronger than its weakest link we can conclude that every one of the present

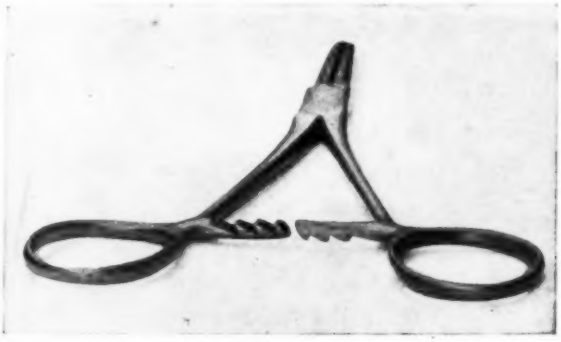


FIG. 1.

types of hemostats now on the market are no stronger than their weakest point, which is the presence of a single ratchet catch on only one shank of the instrument. No matter how sturdy the clamp may be built from every other perfection in manufacture when this one ratchet catch wears down then the life of the clamp is gone and its holding quality is nil.

The clamp herein illustrated is provided with three ratchet catches on each shank of the instrument. This improved feature provides for two factors in the usefulness of the clamp that does not obtain in any other hemostatic forcep on the present day market. First, this clamp has three times the holding strength when applied to pedicles for a short or long time because there are three catches on both shanks holding at the same time and thus minimizing the danger of the clamp coming loose. It has been the custom, when clamps were left on pedicles for a long number of hours, to tie the handles together with strong linen less the clamp should become loosened. This danger is entirely overcome through the arrangement of this improved clamp. Secondly, the economic feature, namely, that this clamp will last just three times as long as the hemostats now on the market. I am informed by expert mechanical engineers that all three ratchet catches on this clamp will not wear uniformly, therefore making the life of the clamp indeterminately long. To support this argument I used a dozen of these clamps continuously for three years at which time the ratchet catches were still holding but they were discarded because the teeth on the jaws had rusted and worn away.

For a period of about twelve years I have sought to get some manufacturer to turn out this style of clamp and in each instance the suggestion was laughed down, presumably because of the durability and lasting quality of this triple ratchet forcep which would necessarily minimize the total sale of hemostatic forceps by the manufacturer. I am glad to say a reputable manufacturer has been sufficiently broad minded to recognize the value and money saving feature to the profession of this clamp and has finally consented to manufacture it for sale at a reasonable price.

The principle can be utilized in making up any style, type or weight of hemostatic forcep. Because this three ratchet catch represents such an economic saving to the profession, by virtue of the long life of the instrument, I have persisted for so many years in my effort to get this improved clamp available to the profession.

* Submitted for publication March 2, 1932.

The American Journal of Surgery

Editor: THURSTON SCOTT WELTON, M.D., F.A.C.S., NEW YORK

Editor, Department of Radiology: JAMES T. CASE, M.D., F.A.C.S., CHICAGO

EDITORIAL BOARD

WALTER C. ALVAREZ, *Rochester, Minn.*; DONALD C. BALFOUR, *Rochester, Minn.*; CARL BECK, *Chicago*; ALEXIS CARREL, *N.Y.*; ROBERT C. COFFEY, *Portland, Ore.*; ISIDORE COHN, *N.O.*; W. B. COLEY, *N.Y.*; GEORGE W. CRILE, *Clev.*; FLLIOTT C. CUTLER, *Clev.*; ROBERT V. DAY, *Los Angeles*; CHARLES A. ELSBERG, *N.Y.*; C. R. G. FORRESTER, *Chicago*; H. DAWSON FURNISS, *N.Y.*; JOHN H. GIBBON, *Phila.*; EMIL GOETSCH, *Brooklyn*; DONALD GUTHRIE, *Sayre, Pa.*; A. E. HERTZLER, *Kansas City*; C. GORDON HEYD, *N.Y.*; LOUIS J. HIRSCHMAN, *Detroit*; JAMES M. HITZROT, *N.Y.*; EMILE F. HOLMAN, *San Francisco*; REGINALD H. JACKSON, *Madison*; JOHN E. JENNINGS, *Brooklyn*; WM. L. KELLER, *Washington*; HOWARD A. KELLY, *Baltimore*; ARTHUR KRIDA, *N.Y.*; A. V. S. LAMBERT, *N.Y.*; H. H. M. LYLE, *N.Y.*; JEROME M. LYNCH, *N.Y.*; URBAN MAES, *N.O.*; ROY D. MCCLURE, *Detroit*; J. TATE MASON, *Seattle*; RUDOLPH MATAS, *N.O.*; H. C. NAFFZIGER, *San Francisco*; E. W. ALTON OCHSNER, *N.O.*; CLARENCE R. O'CROWLEY, *Newark, N.J.*; F. R. PACKARD, *Phila.*; LOUIS E. PHANEUF, *Boston*; E. H. POOL, *N.Y.*; DOUGLAS QUICK, *N.Y.*; HUBERT A. ROYSTER, *Raleigh*; A. C. SCOTT, *Temple, Tex.*; M. G. SEELIG, *St. Louis*; J. BENTLEY SQUIER, *N.Y.*; JOHN E. SUMMERS, *Omaha*; GEORGE W. SWIFT, *Seattle*; J. M. WAINWRIGHT, *Scranton*; GRANT E. WARD, *Balt.*; F. C. WARNSHUIS, *Grand Rapids*; ALLEN O. WHIPPLE, *N.Y.*; J. HOMER WOOLSEY, *San Francisco*.

Foreign Collaborators — GREAT BRITAIN — J. JOHNSTON ABRAHAM, *London*; E. F. FINCH, *Sheffield*; ANDREW FULLERTON, *Belfast*; BASIL HUGHES, *Bradford*; GEOFFREY JEFFERSON, *Manchester*; SIR ROBERT JONES, *Liverpool*; R. E. KELLY, *Liverpool*; G. P. MILLS, *Birmingham*; C. MAX PAGE, *London*; S. S. PRINGLE, *Dublin*; J. J. M. SHAW, *Edinburgh*; H. S. SOUTTAR, *London*; J. H. WATSON, *Burnley*.
FRANCE — G. JEANNENEY, *Bordeaux*. ITALY — RAFFAELE BASTIANELLI, *Rome*.

The American Journal of Surgery is truly independent and enters into no "entangling alliances." It publishes many papers read before the leading surgical societies of the Country, but it is *not* "the official organ" of any organization. Every manuscript is selected by the editors, as worthy of publication—nothing is published merely because "it was read at the meeting."

EDITORIALS

SPINAL ANESTHESIA

IN a recent survey of the department of anesthesia of forty-one hospitals located in widely distributed sections of this country there were correlated 20,185 cases in which spinal anesthesia has been used. From a careful study and review of these spinal anesthesia cases it would seem that sane conclusions can be chosen as to the real value today of this form of anesthesia in surgery.

Of the 20,185 spinal anesthesias, 19,324 were a complete success in so far as producing the desired anesthetic results necessary for the successful completion of the operation in question.

Of the 20,185 cases cited it was reported that in 861 instances this form of anesthesia was not satisfactory. In other words in this number of cases either no anesthetic influence resulted or it was not complete enough to proceed with the operation or the anesthetic influence disappeared in too short a time for the operation to be completed. Where anesthesia had been produced the time of its disappearance varied from fifteen to forty minutes. Thus in one in every 23 cases or 4.3 per cent of the cases the anesthetic influence was either not produced at all or when it was produced it was in some instances only partial while in others it was of short duration.

In this series of collected cases there were reported thirty deaths directly attributable to the spinal injection. This shows a death rate of one in every 672 cases. No cases were reported that the death did not occur within a short time of the spinal injection.

As regards any reactionary or untoward signs or symptoms occurring following spinal injection it was reported that they took place in one form or another in about 90 per cent of the 20,185 cases.

These reactionary or untoward signs and symptoms varied very much in type as well as in severity. Nausea and vomiting were the leading reactions, closely followed in a number of occurrences by lowering of the blood pressure and by some form of respiratory collapse. These four reactionary phenomena occurred in one case or another in about 90 per cent of the cases.

A rather large percentage of the patients attained a state of very free perspiration which appeared in large beads over the face, neck, chest and upper extremities. Headache, of the occipital type, was a very frequent complaint as a subjective symptom. In not a few cases this headache would persist for 24 to 48 hours.

Nervous excitement was another symptom which was present in 10 to 20 per cent of the cases. In one case it was reported that this condition became so extreme that the patient had to be placed in a restraining sheet. This patient however fully recovered after a few hours.

Pallor was a sign which showed itself in a very large percentage of the cases and extreme pallor was reported as being present in over half of the cases.

Subjective weakness was complained of in about 40 per cent of the cases, which passed away in from one to three hours.

A tight feeling about the chest and also dizziness were complained of in from 10 to 15 per cent of the cases. In a few of the reported cases incontinence of feces was reported. A sudden rise of temperature of from 1 to 3° was also reported as having occurred in a few instances.

About 5 per cent of the patients were reported as having complained of pain in one or both of the lower extremities. This pain was rather dull in character, continuous, and involving in some instances the thighs and in others the calf of the leg. In 3 cases a sharp, piercing pain, rather fleeting in character, was reported as present in the lower abdomen.

One anesthetist reported that he found by giving oxygen slowly but continuously through a face mask that many of these untoward signs and symptoms were either entirely eliminated or very materially ameliorated. He found that by thus continuously administering oxygen, nausea, vomiting, lowering of blood pressure, respiratory phenomena, etc. were in all instances much modified and in not a few cases entirely eliminated.

Two large hospitals reported that none of their surgeons would use spinal anesthesia as they considered it unsafe.

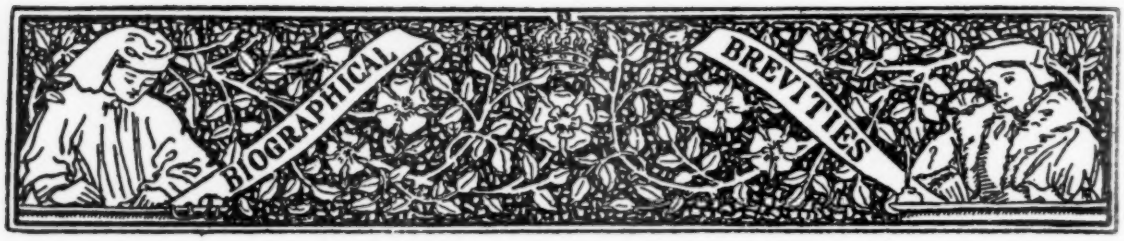
It would appear from this review of a workable number of spinal anesthesia cases that, compared to a general anesthetic such as ether or gas oxygen or a combination of the two, all things considered, a general anesthetic is more dependable and carries with it a very much lower death rate. The same can be said regarding local analgesia, nerve block or spinal root nerve block.

However, it surely can be stated that there are cases where spinal anesthesia is especially indicated, as for instance in patients who have diabetes or a similar disease or conditions where a general anesthetic is contraindicated.

In time a greater experience and wider field of usefulness may and probably will produce a much greater degree of safety in the use of spinal anesthesia. However its usefulness must always remain limited to the extent that some areas demanding operative interference such as the heart, lungs, neck, head, throat, etc. must be done under the influence of an anesthetic of another type.

In emergency war surgery it would seem as if spinal anesthesia must always have its limitations in comparison with other forms. Nevertheless spinal anesthesia appears to be serving well in a very large number of cases and as previously stated no doubt further and wider experience may prove it to be more indispensable than would seem at the present time.

George S. Foster, M.D.



AMERICAN PHYSICIANS

SAMUEL BARD

SAMUEL BARD, son of the physician John B. Bard who was the first one to report a case of extra-uterine pregnancy in America, was born in Philadelphia, April 1, 1742. When he was four years of age the family moved to New York.

When fourteen years old, Samuel entered King's College. In the fall of 1760 he sailed for Europe but was captured by a French privateer and taken to Bayonne where he was confined in the castle. Once he was released he proceeded to London. Recommended by Dr. Fothergill, he was appointed to St. Thomas' Hospital as assistant to Dr. Alexander Russell. Next he went to Edinburgh, graduating in 1765, with great honors.

Dr. Bard returned to New York and began practice with his father. In 1770 he married his cousin, Mary Bard.

Samuel had written his father from abroad that New York should have a medical college. After three years in New York he gained the cooperation of several physicians and in 1768 the school was opened and united to King's College. Bard became professor of the theory and practice of physic. He was twenty-eight years old, the youngest man on the faculty.

Bard was loyal to the Crown and when hostilities began in 1776 he moved to Shrewsbury, N. J. When the British captured and occupied New York Bard returned. He built a large and lucrative practice and soon became rich. Perhaps he remembered Fothergill's words: "I crept over the backs of the poor into the pockets of the rich." After Washington was inaugurated and made New York his headquarters, Bard became his family physician.

Doctor Bard became Dean of the Faculty. He was largely instrumental in the establishment of "The Society of the Hospital of the City of New York in America," in the establishment of the city library, and of the New York Dispensary. He retired from practice in 1798.

In 1811 he was elected an associate fellow of the College of Physicians of Philadelphia. In 1816 the degree of Doctor of Laws was conferred upon him by Princeton College.

In 1771 he published "An Inquiry into the Nature, Cause and Cure of Throat Distemper, as it is called by the Inhabitants of this City and Colony." Having been one of the busiest accoucheurs of his day and vitally interested in the subject, during his days of retirement he wrote for midwives and young practitioners, "A Compendium of the Theory and Practice of Midwifery." He was working on the 6th edition when he died. In 1811 he published "A Guide to Young Shepherds," which for years was considered one of the best authorities on sheep breeding. Several fugitive essays by Bard are preserved in the *American Medical and Philosophical Register*, and *The Transactions of the College of Physicians of Philadelphia* contain several of his papers on yellow fever. In 1819 he wrote "A Discourse on Medical Education."

Samuel Bard died at Hyde Park, N. Y., on May 25, 1821, in his ninetieth year.

T. S. W.

SAMUEL BARD

[1742-1821]

The American Journal of Surgery
N. S. Vol. XVI, May, 1932

[From Fernelius' Universa Medicina, Geneva, 1679.]

BOOKSHELF BROWSING

CONTRIBUTIONS OF ANIMAL EXPERIMENTATION TO MEDICAL PROGRESS

ENDOCRINOLOGY*

J. M. ROGOFF, M.D.

CLEVELAND, O.

IT is not surprising that as physics and chemistry became more intimately associated with biology, permitting more fundamental observations to be made on the processes of life, medical progress was influenced so greatly that it advanced much more rapidly within the past three centuries than in all preceding periods. The greatest progress in the prevention and cure of disease has been made during the past fifty to one-hundred years. In the beginning of the second half of the nineteenth century the foundation for modern experimental medicine was laid by the eminent physiologist, Claude Bernard. The use of anesthetics in surgical procedures had been recently introduced and was advancing. This made possible the use of animals for experimental investigations, under humane conditions, and gave rise to valuable research in all fields of biological science.

Bernard's investigations on the glycogenic function of the liver, the studies by his pupil, Brown-Sequard in 1856, on the effects of removal of the adrenal glands, and the pioneer experiments in the same period, by Moritz Schiff, on the thyroid gland were the beginnings of our present knowledge in endocrinology. Thus, this subject is a direct outgrowth of experimental medicine.

Various conceptions of the process of internal secretion have prevailed since about the middle of the 18th century. The modern idea of this process, however, is founded upon Bernard's demonstration of the elaboration, storage and use of liver-glycogen and the statement of his belief that other organs like the thyroid, suprarenals and spleen furnish an internal secretion. A definite relationship between certain diseases and the disturbed functions of various organs known or believed to furnish essential internal secretions, was established through the correlation of physiological experimentation upon animals, clinical observation, and pathological examination. The relation of certain morbid changes in the adrenal glands to the syndrome known as Addison's disease was described in 1855; and later the importance of certain endocrine organs was demonstrated by observations on the relations

* This is the fourth of a series of articles on the value of animal experimentation in medical progress. The next article will appear in an early issue.

of the thyroid gland to myxoedema and cretinism, of the pituitary to acromegaly and other conditions, and of the pancreas to diabetes. A number of other diseases are known to be associated with abnormalities in structure or function of certain organs or glands believed to furnish internal secretions.

The group of organs known as the *endocrine glands* includes the adrenal, thyroid, parathyroid, thymus, pituitary, pineal, pancreas, liver, spleen and the gonads or sex glands. Nearly all of these organs have been known to anatomists for a long time. Yet their functions have remained a complete mystery prior to the advent of modern experimental medicine. They have been generally classed as the ductless glands inasmuch as the specific active substances, or "hormones," which they elaborate are discharged directly into the blood or lymph which passes through the organs. This distinguishes their *internal* secretions from external secretions, which are discharged upon a surface or into channels and carried away from the cells or organs that produce them. In a broader sense the term *internal secretion* has been used to include products of the metabolism of cells in organs or tissues other than the glands above mentioned, but for the present purpose we shall limit the use of this term to the products of these glands.

For the prevention and cure of disease we need an understanding of the immediate and remote causes which underly disturbances of normal processes. Systematic clinical studies and post mortem examinations yield valuable information on the relation of special organs to certain diseases; but a diseased condition can be satisfactorily understood and corrected only when the normal physiological processes of the organs in question are known. In the case of the endocrine glands, their functional significance is generally investigated experimentally by creating a deficiency of function through surgical removal or destruction of the organs. The resulting condition is studied and compared with conditions that are known clinically to be associated with disorders of such organs. Correction of the deficiency is then undertaken by attempting to compensate for the loss of the glands. This is sometimes accomplished by feeding desiccated gland products, by transplantation, or by administration of extracts of the gland. Where active products of endocrine glands have been obtained it has been possible not only to study and correct deficiencies but to learn the relation of excessive function to certain maladies. Ultimately, the isolation, from an endocrine gland, of a specific *hormone*, its identification, and knowledge concerning its elaboration, storage and secretion by the gland, lead to a clearer understanding of normal function and to the correction or prevention of abnormal conditions of the organ.

INSULIN

The experiments of von Mering and Minkowski, in 1889, strikingly demonstrated an intimate relationship between the pancreas and carbohydrate metabolism. They discovered that animals from which the pancreas had been removed developed a diabetic condition. This suggested the existence of an internal secretion, from this organ, having an important influence upon metabolism of sugar. Numerous attempts to isolate the active product of this secretion followed, some of them with a measure of success. Extracts prepared from the glands were found to be capable of exerting a favorable influence upon the hyperglycemia and glycosuria which followed surgical extirpation of the pancreas, in laboratory animals. Numerous experiments on animals by various investigators contributed substantially to our further knowledge until insulin was successfully prepared. The final steps were elaborated by a group of investigators working under the direction of Macleod. Banting and Best prepared extracts of pancreas, after destruction of the alveolar tissue by ligating the duct of Wirsung, leaving the insular tissue. Thus the destructive action

of the digestive enzymes of the gland was avoided, and preparations of high potency were obtained. Collip purified the preparations by fractional precipitation of the extracts, with alcohol, rendering them suitable for parenteral administration in human beings.

Space will not permit consideration of all the endocrine organs, nor of detailed discussion of much of the experimental work concerning any of them. An analysis of the experimental studies on the adrenal glands and a brief review of some of the outstanding experimental work on the thyroid will suffice to illustrate the method and the results in this field.

THE ADRENAL GLANDS (SUPRARENAL CAPSULES)

The adrenal glands are indispensable for life. Failure of their function leads to a fatal malady, Addison's disease. They were the first of the endocrine organs for which a relationship was demonstrated between disturbed function and a certain definite disease. A number of valuable contributions have resulted from studies concerning the adrenals, and important investigations are in progress. Indispensability of the "suprarenal capsules" for life and health was established by Thomas Addison in 1855. While engaged in a study of certain types of anemia, he observed a number of cases which clinically resembled primary anemia, yet differed sufficiently to enable him to classify them as manifestations of a definite syndrome, associated with disease of the suprarenal capsules. He described 11 cases in which he found certain characteristic symptoms and which all terminated in death within a relatively short time. Postmortem examination revealed disease or destruction of the suprarenal glands. Chief among the symptoms were profound muscular and cardiovascular asthenia, gastrointestinal disturbances, and development of a characteristic pigmentation of the skin. This condition, known as Addison's disease, is not frequently encountered but if always recognized would unquestionably be found to exist less rarely than has hitherto been supposed.

Although it is three-quarters of a century since this disease was clearly recognized, and a considerable number of cases have been carefully studied, clinically and pathologically, very little has been added to our knowledge of the syndrome, and its treatment has hitherto been unsuccessful. Recently, however, experimental studies on adrenal insufficiency, conducted by the writer in collaboration with G. N. Stewart, have thrown some light upon the subject and have led to treatment of Addison's disease with encouraging and hopeful results. Addison's disease is but one manifestation of adrenal insufficiency and is the most severe one. Doubtless there exist less severe disturbances of adrenal function. But recognition of these conditions and successful treatment of them can be expected only when the normal function of the adrenal glands is more thoroughly understood.

The existence of these organs has been known for centuries. An accurate anatomical description of them was given by Eustachius in 1563. Various theories regarding the function of the adrenals have prevailed from time to time, based upon anatomical observations. These views illustrate how hopelessly investigators were compelled to grope in the dark, unaided by the light of modern experimental methods. Thus, the adrenal glands were supposed to "hold up the stomach and strengthen the nervous plexus which touches them." They were believed to collect the "humidities" which leak out of the large vessels in the neighborhood; or that within their cavities is preserved "black bile." "Some think they separate a Liquor from the Arterial Blood, for diluting the Blood, which is too thick after it comes from the Kidneys" (Lexicon Physico-Medicum; John Quincy, 1719).

Physiological investigations, upon animals, were begun by Brown-Sequard and followed by a number of other workers as soon as Addison demonstrated the relation

of the adrenals to the syndrome which bears his name. Attempts were made to create adrenal insufficiency, experimentally, in frogs, rats, cats, dogs, rabbits and guinea pigs, by surgical removal or destruction of the glands. The results obtained by most earlier and many recent investigators cannot be considered satisfactory, but they illustrate some of the great difficulties that must be overcome in experiments of this kind. The intimate anatomical relationship of the adrenal glands with important sympathetic nerve structures necessitates special skill and technique for their extirpation. Careful anesthesia and the strictest precautions of modern surgery must be exercised in the preparation of the animal, in the operation, and in the postoperative care.

Thus far, it has not been found possible to create, in animals, a condition identical with Addison's disease, although excision of the adrenals gives rise to symptoms commonly associated with that disease. But it has been thoroughly established that the glands are indispensable for life and health. This was indicated even by the results of some of the earlier and necessarily poorer operations for removal or destruction of the adrenals. Knowledge of the indispensability of the organs naturally led to the view that the adrenals either supply a substance which is essential for life or that they act by destroying certain harmful toxic substances which, in the absence of the glands, accumulate in the body.

ADRENALIN

In 1895, Oliver and Schaefer published results of experiments made to determine whether a physiologically potent product could be obtained from the adrenals. They made the very interesting observation that extracts, prepared from the glands, when injected into the circulation of animals, caused a remarkable elevation of the blood pressure. Further, it was found that this was a property of extracts made from the central portion, or medulla, of the gland. Within a few years after this discovery the active substance, *adrenalin*, was isolated and prepared in pure form by Aldrich and by Takamine (1901). Demonstration of the presence of this product, in the gland, however, still left unsettled the question whether it represents an indispensable secretion or is the product of a detoxicating function, stored in the organ and later destroyed or slowly eliminated. It became necessary to determine whether this material is actually secreted from the gland, the rate of its secretion and whether the quantities ordinarily liberated are capable of exercising important physiological functions. The problem presented many difficulties, especially in the development of adequate quantitative methods for obtaining the essential information.

The availability of adrenalin, in pure form, led to extensive pharmacological studies and it soon found a place as one of the most useful therapeutic agents employed in medicine. Thus, its powerful influence in raising blood pressure, when injected into animals, demonstrated its usefulness in circulatory collapse and rendered it extremely valuable in combatting shock. Indeed, this remarkable property of adrenalin suggested the theory that the function of its secretion by the adrenal glands is concerned with maintenance of normal blood pressure, hypersecretion resulting in excessive pressure and hyposecretion in low blood pressure. An important influence of the adrenal glands, in carbohydrate metabolism, has been suggested from the observation that adrenalin is capable of increasing the amount of sugar in the blood. The physiological actions of adrenalin have been determined, from studies upon various species of animals.

It has been found that the action of adrenalin upon organs that are innervated by sympathetic nerves is the same as the effect produced by electrical stimulation of these nerves. This "sympathomimetic" action of adrenalin, therefore, is capable of simulating certain reactions that are com-

monly associated with the responses to violent emotions. Upon some of the various effects following the administration of adrenalin there has been founded a theory of an "emergency function" of the adrenals, whereby the glands respond to major emotions by "outbursts" of the secretion. This theory, frequently accepted in modern teaching of psychology, and by some physiologists, is, of course, based upon the assumption that the adrenals are capable of liberating such quantities of adrenalin as are necessary to cause the above mentioned responses.

Various theories to explain the function of these glands are based largely upon pharmacological actions of adrenalin. We know, however, that physiological interpretations based on pharmacological reactions or on clinical observations alone too often lead to error. At the time that these theories were proposed no adequate methods for making quantitative studies upon the rate of epinephrin* secretion from the adrenals, had yet been developed. The most satisfactory method that is now available for such studies is very laborious but has yielded consistent quantitative data on the ordinary rate of epinephrin secretion and on some of the conditions capable of modifying that rate.

The concentration of epinephrin in the normal systemic circulation is too low to permit its estimation by the most sensitive methods at present available. From the concentrations usually found in the adrenal vein blood it is estimated that the concentration in the general arterial blood cannot exceed about 1:1,000,000,000 to 1:2,000,000,000 under ordinary physiological conditions. To determine the rate of secretion of epinephrin from the adrenal glands it is necessary to know the rate at which blood flows from the glands and the concentration of epinephrin in that blood. The method for making these measurements in an anesthetized animal consists of isolating a portion of the vena cava so that only the blood from the adrenal glands enter it. The blood is collected through this "cava pocket" and the quantity obtained in a known time is measured, permitting determination of the rate of blood flow from the organs. The epinephrin concentration in the adrenal blood is then determined by the aid of reactions upon segments of rabbits' intestine and uterus. This yields the necessary information for computing the rate of epinephrin secretion. The average rate, under ordinary experimental conditions, has been found to be very much less than the quantities employed in various pharmacological studies upon which certain theories of adrenal function have been founded.

In animals, anesthetized with either volatile (ether, chloroform) or non-volatile (urethane, chloretone) anesthetics, the average rate of epinephrin secretion, from the adrenal glands, has been determined at 0.000225 mgm. per minute per kgm. of body weight. It has been demonstrated that liberation of epinephrin is dependent upon the integrity of the nervous mechanism which governs the activity of the adrenal medulla. Thus, the secretion can be suppressed by interference with the nerve supply; it is augmented by stimulation of the splanchnic nerve; it can be abolished by transection of the spinal cord, in the upper dorsal region; and hemisection, in this region, suppresses the secretion from the adrenal on the same side as the cord section. Certain drugs (strychnine, nicotine, physostigmine) greatly increase the epinephrin output while other drugs (curara) depress it.

It has been found experimentally that epinephrin, secreted at the ordinary rate, can, under certain conditions, exert actions which may have functional significance; e.g. certain action upon the heart. From the regulation of the secretion, at a constant rate, through the nervous system it may be assumed that it exercises a physiological function. On the other hand,

*The term *epinephrin* has been generally accepted to designate the physiological secretion from the medulla of the adrenal glands and to distinguish it from the commercial product, *adrenalin*.

it is not unlikely that the regulation is such that the rate of secretion is not high enough to produce harmful effects, but

embryonic structures, and in certain fishes they exist as two separate glands known as the *interrenal* and the *chromaffin bodies.*

FIG. 1A. FIG. 1B.

FIG. 1. A, Animal comatose on fifth day following complete adrenalectomy. B, Recovery after intravenous injections of saline-dextrose solution. An injection was given daily and the animal survived, in good health, for over thirty-three days.

makes possible the gradual destruction or elimination of the epinephrin.

In any case, whatever the function of epinephrin may be, it is not the indispensable function of the adrenals. For it is possible to suppress, totally, the epinephrin secretion in an animal, by excision of one adrenal and denervation of the other gland. In addition, the medulla of the remaining gland can be destroyed. If a sufficient amount of the outer layer or cortex, of the gland has been left intact the animal will survive indefinitely, in excellent health. Unquestionably, the important function of the adrenals is not performed by the secretion of epinephrin but rests in the cortex or *interrenal* tissue of the glands. It is not surprising, however, that to epinephrin has been attributed the important function of the glands, since its secretion and the pharmacological effects of adrenalin were demonstrated at a time when very little was known about the cortex.

THE CORTEX OR INTERRENAL TISSUE

It is obvious that functionally the adrenal gland must be considered as consisting of two different glands. Anatomically, they are derived from different

In mammals, they become united in the course of development. Experimental evidence obtained within the past few years, and researches still in progress, in our laboratory, have demonstrated that disturbance or loss of function of the interrenal, and not that of the chromaffin tissue, is responsible for the syndrome known as Addison's disease.

If, under the most exacting surgical conditions, an animal is deprived of both adrenal glands it survives for only a relatively short time. Among certain animals (rats, rabbits) it is frequently found that removal of the adrenals does not lead to a fatal outcome. In such animals, it has been observed that there are present accessory adrenal bodies consisting of interrenal tissue: these suffice to sustain life in the absence of the adrenals. The symptoms which develop as the result of depriving an animal of its adrenals include loss of appetite, aversion to fatty food, gastrointestinal disorders (vomiting, often of bile), muscular weakness, circulatory disturbances and symptoms referable to the central nervous system (hallucinations, sometimes convulsions and coma). In addition, as these symptoms develop, exami-

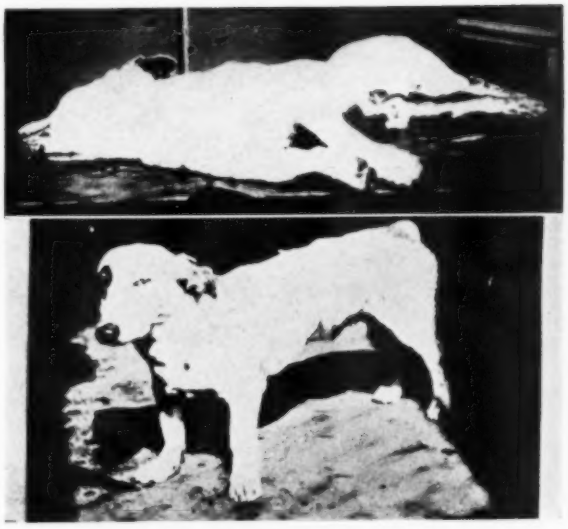
nation of the blood reveals a marked increase in the total non-protein nitrogen, the urea nitrogen and the "undetermined" nitrogenous fraction. The percentage of sugar is usually below normal and in most cases there is concentration of the blood.

The condition indicates development of a very severe and rapidly fatal intoxication. For a number of days following adrenalectomy there is a period of good health, during which the animal is indistinguishable from normal animals. The symptoms develop about two or three days before death, rapidly increasing in severity. It has been demonstrated that the onset of symptoms can be postponed or, when already present, they can be relieved, and the life of the animal greatly prolonged, by intravenous injections of physiological salt solutions. This dilutes toxic material and facilitates its elimination. Similar beneficial influence is exerted by administration of certain extracts prepared by us from the cortex of adrenals. Such extracts compensate for the loss of the adrenals by supplying *Interrenalin*, the active principle or hormone of the interrenal or cortical tissue.

ADDISON'S DISEASE

Since 1915 extensive experimental studies upon animals have been in progress, at The Laboratory of Experimental Medicine of Western Reserve University, aiming to determine the physiological significance of the adrenal glands and their relationship to certain morbid conditions. The fundamental information obtained experimentally was applied, at the same time, in clinical studies upon Addison's disease. These studies have led to a different concept of the adrenal functional disturbances associated with the disease from that which had previously prevailed. Addison's disease was generally interpreted as a manifestation or result of insufficient epinephrin secretion. Some clinicians still adhere to this view and employ methods of treatment that include unsuccessful attempts to compensate for a supposed lack of circulating epinephrin, by administering adrenalin. We have already pointed out that epinephrin secretion can

FIG. 2A.



FIGS. 2B AND 2C.

FIG. 2. A, Dog in excellent condition, thirty-two days after complete adrenalectomy, having received daily injections of adrenal cortical extract (interrenalin). B, Convulsions and coma (developed on the thirty-sixth day). C, Recovery following administration of Ringer's solution, in addition to the interrenalin. The animal survived forty-three days.

be suppressed without harmful results. The newer concepts, derived from the proof that the interrenal tissue is indispensable, are the *basis* of treatment employed by the writer; and this has thus far proven more beneficial in Addison's disease than any other treatment heretofore employed. It consists of administration of certain

preparations made from adrenal *cortex* with the object of supplying *interrenalin* and, in addition, intravenous administration of

(*viz.* gastrointestinal derangements, muscular and circulatory asthenia, nervous system disturbances) occur in both cases.

FIG. 3A. FIG. 3B.

FIG. 3. A, Normal animal B, Dog from same litter with thyroidectomy performed at the age of three weeks. (Biedl.)

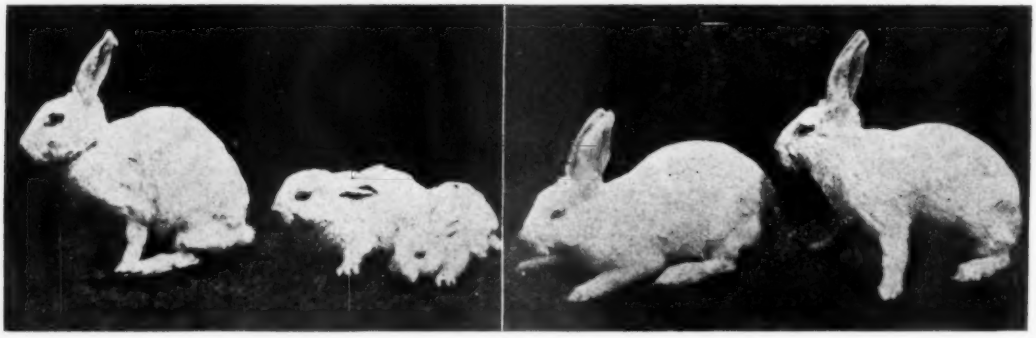


FIG. 4A. FIG. 4B.

FIG. 4. A, Normal control rabbit and two cretins (thyroidectomized) from same litter. B, Normal control rabbit (right), and cretin from same litter fed with standard thyroid preparation. (From Basinger.)

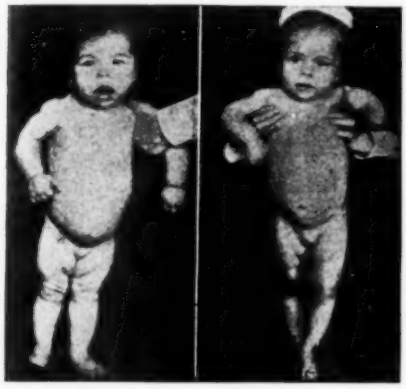
physiological salt solution to correct or prevent development of the characteristic intoxication. This treatment is based upon the previously mentioned beneficial influence of similar treatment applied in our experimental work with adrenalectomised animals.

The condition which follows surgical removal of the adrenal glands in animals is not identical with that seen in human beings with Addison's disease. This is to be expected since in one case there is acute total suppression of adrenal function while in the other the disease is more chronic and is usually associated with other conditions, commonly tuberculosis. Nevertheless, certain of the symptoms The significance of these symptoms has already been alluded to.

In animals deprived of their adrenals under proper surgical conditions there is no significant alteration in the blood pressure during the period of survival until the appearance of symptoms indicating an intoxication. In Addison's disease the blood pressure is low, a condition heretofore attributed to interference with the secretion of epinephrin from the adrenal glands. However, in the light of proof afforded by experiments upon animals and from clinical studies on Addison's disease, we must consider the low blood pressure as a manifestation of the intoxication which results from interference with function of

the interrenal or cortical, rather than of the medullary, tissue of the adrenal glands.

Unfortunately, the diagnosis of Addi-

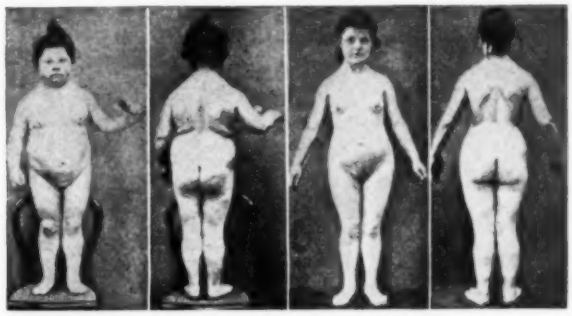


A B

Fig. 5. Cretinous child (A) before and (B) after treatment with thyroid. (Byrom Bramwell.) (From Sharpey-Schafer.)

son's disease is rarely made until the intoxication has progressed to the stage where the symptoms are fully developed, including the low blood pressure. But we have observed the existence of the other symptoms (including pigmentation of the skin) when the blood pressure was normal. In such cases the diagnosis has been questioned; but within a relatively short time doubt was removed by a more or less rapid decline of the pressure and perhaps the occurrence of an acute exacerbation with gastrointestinal and nervous symptoms. In these cases, especially, the writer has witnessed remarkable improvement following administration of interrenalin, sometimes supplemented by intravenous administration of salt solution to facilitate elimination of toxic substances. Even marked reduction of pigmentation has occurred.

It is now necessary to isolate the active product "interrenalin" in purer form, and to learn the manner in which it operates, we need also to learn how to recognize abnormal function or deficiency (e.g. Addison's disease) readily, and before irreparable damage is done. The results so far obtained are encouraging. They demonstrate the value of animal experimentation and the importance of continued investigation. The remaining problems will be



A B C D

Fig. 6. A and B, Partial myxedema in fifteen-year-old girl. C and D, After treatment for three and one-half years with thyroid medication. (Leopold-Lévi and de Rothschild.) (From Biedl.)

solved only by the aid of further research upon animals.

THE THYROID GLAND

A striking example of the indispensability of animal experimentation for the advancement of our knowledge in medicine and surgery is afforded by the progress made during the past twenty-five to fifty years in our understanding and treatment of diseases related to the thyroid gland. Prior to the advent of modern experimental medicine the concepts of thyroid function were based upon anatomy. The intimate relationship of the thyroid with the larynx gave rise to the belief that the gland has the function of lubricating the throat and aiding the voice. This idea existed from the time of Galen up to the middle of the nineteenth century.

A historical review of the subject, which cannot be attempted here, reveals numerous other examples of hypothetical explanations of the rôle of the thyroid based upon anatomy, before the introduction of experimental work upon animals, by Moritz Schiff.

From none of the theories was any progress made toward the recognition and treatment of conditions associated with thyroid disturbances. Nothing was con-

tributed to our knowledge of the important metabolic influence of the thyroid and its relation to certain diseases. The successful

FIG. 7A.

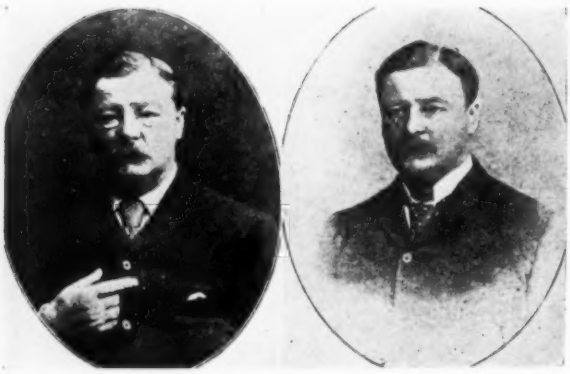


FIG. 7B.

FIG. 7. Upper, myxedema (A) before and (B) after seven months' treatment with thyroid medication. (Andersson.) (From Biedl.) Lower, A, myxedema in man aged forty-four of two years' duration and B, after six weeks' treatment with thyroid extract (Murray). (From Vincent.)

treatment of cretinism and of myxoedema, and the prevention of simple or endemic goiter, which have already been accomplished by the aid of animal experimentation, would not have been possible from anatomical studies alone. Functional activity of the thyroid and its relation to functions of other organs are now more clearly understood. More comprehensive information on the physiology of the thyroid and its abnormal function in disease must be obtained by further investigation.

CRETINISM

This condition, also known as "infantile myxoedema" or "cretinoid idiocy" is a chronic disease of childhood characterized by stunted growth, deformity of body, and imbecility. It commonly develops at one to two years of age but may appear soon after birth or at any time up to puberty. Until about a quarter of a century ago it was generally included among the hopeless mental derangements. In certain regions this disease was very common, occurring endemically, especially in goiter districts. Sporadic cases also were not uncommon throughout the civilized world.

Cretinism and myxedema have been reproduced in animals and the functional derangements as well as treatment have been studied. The function of the thyroid and its relation to myxedema, cretinism, simple and toxic goiter and certain other conditions, though much better understood are not as yet completely known. The gland possesses a unique affinity for iodine and stores this substance, in organic combination, in a form which is capable of exerting a powerful influence upon metabolism. Baumann, in 1895, demonstrated the presence of iodine in the thyroid and in 1919 Kendall isolated the active iodine compound, *thyroxin*, which is considered to be the specific hormone of the gland.

The relation of iodine to simple goiter has been studied by David Marine and collaborators. He recognized the remarkable affinity of the thyroid for this substance and demonstrated, in animals, that very small quantities of iodides are capable of converting a hyperplastic gland into one possessing the normal colloid material. Their observations led to the use of small doses of iodides as an effective measure for the prevention of simple goiter.

Prior to 1891, treatment of cretinism was utterly hopeless. And then came the use of thyroid extracts and glandular products as remedial agents. The extraordinary results obtained are best de-

scribed in the words of Sir William Osler (1897), "Not the magic wand of Prospero or the brave kiss of the daughter of Hippocrates ever effected such a change as that which we are now enabled to make in these unfortunate victims, doomed heretofore to live in hopeless imbecility, an unspeakable affliction to their parents and to their relatives."

This is an outcome of experimentation upon animals begun in 1854, by Moritz Schiff. His earlier experiments on removal of the thyroid resulted in death of a number of animals within a few days and survival of others which, however, developed a cachectic condition. About twenty-five years later Schiff was led to repeat his earlier studies, in the light of more recent knowledge. The discovery of the parathyroids, in 1880, by Sandström, Reverdin's successful production of experimental myxoedema, in 1882 and the report by Kocher, in 1883, that 30 per cent of thyroidectomies were followed by a "cachexia strumipriva," led Schiff to repeat his experiments of a quarter of a century earlier and in 1884 he demonstrated that thyroidectomized animals could be saved by previous grafting of the gland. Schiff pointed out the endocrine nature of thyroid function and suggested substitution therapy in myxedema.

The relation of absence of the thyroid to defective cerebral development and myxedema was noted by Curling, in 1850. Later, Semon pointed out that cretinism, myxedema and cachexia thyreo-strumipriva are identical. The results of Schiff's experiments led Murray, in 1891, to employ injection of extracts of thyroid in the treatment of these conditions, with satisfactory results. One year later, it was found by Howitz that administration of the gland by mouth is effective. Since then successful substitution therapy, in the treatment of disorders associated with thyroid insufficiency, has constituted one of the most striking achievements of modern experimental medicine.

In the foregoing we have attempted to illustrate some of the chief steps in the evolution of our knowledge in endocrinology. The adrenal has been considered more extensively; since it is one of the most important organs in the body and so little is known concerning its function, it affords an excellent demonstration of the contributions that have been and are being made, in this branch of medicine, chiefly through animal experimentation. Progress is necessarily slow. Every contribution to our knowledge leads to new problems. The process of investigation must be continuous, extensive and cooperative; clinical observation and animal experimentation must be coordinated if the "Art" of healing is finally to find its proper place in civilization as a useful "Science."

BOOK REVIEWS

INTRACRANIAL TUMOURS, Notes upon a Series of Two Thousand Verified Cases with Surgical-mortality Percentages Pertaining Thereto. By Harvey Cushing. Springfield, Ill., Charles C. Thomas, 1932. 150 pp.

The author of this volume is today undoubtedly the outstanding surgeon of the United States, if not of the world. Anything emanating from his pen is entitled to more than usual consideration. Add to this the fact that this monograph consists of a report on over two thousand brain tumors verified by either operation or postmortem examination in one clinic, and it is readily appreciated that we have before us an outstanding work. This volume formed the basis of the report made by Dr. Cushing to the International Neurological Congress held in Berne in September, 1931. His paper was recognized as the principal contribution to this important Congress. While consisting largely of statistics, there have been added explanatory paragraphs whose purpose, according to the author, "was to make the tabulations and percentages appended to the several sections more easily comprehended."

A proper review of this volume would call for a detailed analysis of its contents which is not feasible at the present time. Suffice it to say that anyone attempting brain surgery should have this important monograph at hand for continued reference. It is perfectly astounding to see the amount of information that the author has succeeded in condensing into 150 pages. The 111 illustrations render the production of incalculable value, not only for reference but as an actual handbook for the brain surgeon.

The enthusiasm of the reviewer for this volume could easily lead to his usurping all the space allowed to book reviews in this issue.

TUMOURS OF THE BREAST. Their Pathology, Symptoms, Diagnosis and Treatment. By Sir G. Lenthal Cheatle, K.C.B., C.V.O., F.R.C.S., and Max Cutler, B.SC., M.D., Phila., J. B. Lippincott Co., 1931. 596 pp., 486 illus.

This volume really includes a pathological atlas and covers this subject as well as any single volume known to the reviewer. The subject is covered completely in fourteen chapters with due consideration to both the surgical and radiological treatment. It contains a complete discussion of pathology and diagnosis.

A splendid volume in every way and one which should find its place in the library of every surgeon who comes in contact with tumors of the breast.

MONOGRAPHS ON SURGICAL PATHOLOGY. By Arthur E. Hertzler. Halstead, Kansas. Phila., J. B. Lippincott Co., 1931.

SURGICAL PATHOLOGY OF THE DISEASES OF BONES. 272 pp., 211 illus., 1930–31.

SURGICAL PATHOLOGY OF THE SKIN, FASCIA, MUSCLES, TENDONS, BLOOD AND LYMPH VESSELS, 301 pp., 260 illus., 1931.

SURGICAL PATHOLOGY OF THE FEMALE GENERATIVE ORGANS. 346 pp., 285 illus., 1932.

SURGICAL PATHOLOGY OF THE GENITO-URINARY ORGANS. 286 pp., 222 illus., 1931.

These volumes are the first of ten which will comprise a complete system of surgical pathology. They present the deep studies of an active surgeon. The idea of a volume on each subject allows of sufficient elaboration to make this a worthy work of reference and a credit to American surgical literature. The illustrations are well selected and carefully reproduced. The bibliography which follows each chapter is complete enough for all practical purposes without being so extensive as to be boresome. The subject is treated so that it may be quickly referred to by the practicing surgeon.

In the Preface to the volume on the Skin, Fascia, Muscles, Tendons, Blood and Lymph Vessels, the author states as follows: "The purpose of the book is to present the result of observations in the clinic, or operating room with only incidental discussions of the findings

of the laboratory. Pathologists will therefore please ignore the presentation of my own views. I have no quarrel either with them or with science; it is the art of medicine I seek to serve." This statement serves as the keynote to the ideas behind this series. Many surgeons will find themselves in complete sympathy with his ideas whereas others will disagree.

If the remaining six volumes live up to the status of the first four, the author will have achieved his aim of "serving the art of medicine."

Clinical Roentgen Pathology of Thoracic Lesions. By William H. Meyer, M.D. Phila., Lea & Febiger, 1932, 261 pp., 183 engravings.

According to the author's preface this is the first of a series of volumes on interpretation of roentgen plates. This volume considers abnormalities and diseases of the respiratory tract and will make a splendid book for the beginner, though of course not nearly as complete as the larger atlases such as the American Sante and the German Assmann. There are 183 illustrations most of them fairly well reproduced. The lack of a bibliography is to be deplored and it is hoped that the author will at least add references for further reading to the various chapters of his future volumes.

Surgical Errors and Safeguards-By Max Thorek, M.D. Phila., J. B. Lippincott Co., 1932. 696 pp., 668 illus.

This volume of 700 pages will make valuable auxiliary reading for any surgeon but, particularly, for the young man. Well arranged, well illustrated and well indexed, the volume lends itself particularly well to quick reference in a perplexing case. This is a valuable book for which we predict a large sale.

The Story of Medicine, from Medicine Man to Modern Physician. By Victor Robinson, M.D. N. Y., Albert & Charles Boni, 1931. 527 pp.

The author of this book has a sense of the dramatic and shows a distinct flair for news and human interest, particularly of the tabloid variety. Here is the story of medicine jazzed up for this modern age. The cynicism, often miscalled debunking, so evident in historical writing in recent years is here applied to medical lore with a vengeance.

Chapter XII starts off with the following paragraph: "America is the youngest of the great nations, and if it seems strange that we know no more of the first English physicians in America than of the first Greek physicians in Rome, the same reason is operative in both instances. Eminent physicians remain at home, if for no other purpose than to annoy their rivals, and are not likely to be found on the first ship that touches a new shore. In the year that Jamestown was settled (1607), William Harvey was elected a Fellow of the Royal College of Physicians, and his prospects in London looked brighter than in Virginia; when the Half-Moon sailed up the river that we now call the Hudson (1609), Thomas Fryer, Graduate of Cambridge and Padua, was enjoying the honors of Consiliarius, when the Pilgrims landed on Plymouth Rock (1620), the Oxonian Matthew Gwinne was appointed Tobacco Inspector by James I, the royal enemy of the weed. Such men, professionally or socially successful, had no incentive to follow fortune in a wilderness. The social standing that comes to first settlers is always posthumous." Granting all of this possibly to be true, it does not seem that much is added to the undergraduate student's knowledge or respect for history of medicine to have it presented in this fashion.

The story of Burke and Hare, the body snatchers of the early nineteenth century, is interesting. But whether in a book of a little over 500 pages covering the subject from "Medicine Man to Modern Medicine" this dramatic episode is entitled to some ten pages (374–385) is questionable.

The problem presents itself—for whom is this book written? If for the undergraduate student of medicine, it is felt that there are many books ranging from the smaller volumes of Dana, Seelig, Dawson and others through the larger volumes of Baas, Pagel, and the incomparable Garrison, which present the subject in much better fashion for this class of reader. The physician also has numerous volumes at his disposal which will present the information he is looking for far more adequately. For the layman, it will perhaps make more interesting reading than the more serious

volumes. But there is great doubt as to whether it is necessary or desirable to present to the layman all the scandals of medicine which, after all, form the high spots of this volume.

Taken all in all, the book is without a doubt entertainingly written, fairly accurate in its factual presentation but perhaps unnecessarily lurid in style.

THE FUNDUS OF THE HUMAN EYE, AN ILLUSTRATED ATLAS FOR THE PHYSICIAN. By Ernest Clarke, C.V.O., M.D., F.R.C.S. Lond., Humphrey Milford, Oxford University Press, 1931. 51 plates.

The author of this modern book on "The Fundus of the Human Eye" thirty-five years ago translated Haab's classic book on this subject. His new work will make a worthy successor of this old standby which has long been out of print. The book should be of especial value to the general practitioner as only the most definite fundus changes have been illustrated. There are fifty-one plates, all of them splendid reproductions. The atlas, which is low in price, should find a place on the reference shelf of every physician using the ophthalmoscope. The specialist, of course, will require more complete works.

A TEXT-BOOK OF MEDICINE FOR NURSES. By E. Noble Chamberlain, M.D., M.SC., M.R.C.P., Foreword by Miss E. M. Musson, C.B.E., R.R.C. Lond., Humphrey Milford, Oxford Univ. Press, 1931, 378 pages.

This book is well named A Text-book of Medicine For Nurses. It is well written, well illustrated, and well planned. The book will undoubtedly meet the needs of the English schools of nursing but in this country will be found by many to contain too many details which are not required in our nurses' training. It should be in every reference library for nurses.

GYNÄKOLOGISCHE OPERATIONSLEHRE. By Prof. Dr. Josef Halban. Berlin, Urban & Schwarzenberg, 1932.

In his introduction, Professor Halban offers as his excuse for the publication of this work on Operative Gynecology, firstly, the existence of a great many methods of performing similar operations; and, secondly, to lend this work his personal equation in relation to, "not only if and when to operate, but also how." In this he has succeeded well; for though the book contains only 435 pages, the author covers indications, methods of choice and technique for all pelvic and most of the abdominal surgical procedures. The reviewer mentions "abdominal surgery" advisedly; for though the book is termed "Operative Gynecology" the author includes indications and operative procedures for all types of hernias, bladder, ureter and kidney surgery; intestinal surgery, and the usual types of rectal operations. Professor Halban feels that a gynecologist should be able to cope with, and be able to perform any operation in the abdomen as well as in the pelvis.

The book is divided into two sections. The first of these is devoted to the discussion of general subjects; as, preoperative preparation, various forms of anaesthesia, including his method of spinal induction, blood transfusion, postoperative treatment of hemorrhage, emboli, etc. In the second part, he covers the indications and the technique of the various gynecological, urological and intestinal operations.

The inclusion in the book of chapters on infertility, artificial insemination, methods of temporary sterilization, etc., makes it all the more interesting.

The four hundred illustrations, many in colors, are superb.

PERIPHERAL NERVE INJURIES

LEWIS J. POLLOCK, M.D.

AND

LOYAL DAVIS, M.D.

FIFTH INSTALLMENT

CONTENTS

[This Number]

Chapter		Page
XIX.	Surgical Technique of Nerve Operations	353
XX.	Postoperative Treatment	377

[Previously Issued]

		Vol. XV
I.	The Incidence of Peripheral Nerve Injuries	179
II.	Examination: History; General Examination	183
III.	Examination (*Cont.*): Motion	185
IV.	Examination (*Cont.*): Subjective Sensory Disturbances	390
V.	Examination (*Cont.*): Causalgia	395
VI.	Examination (*Cont.*): Objective Sensory Disturbances	403
VII.	Examination (*Cont.*): Nerve Overlap	411
VIII.	Examination (*Cont.*): Vasomotor, Trophic and Secretory Disturbances	573
IX.	Examination (*Cont.*): Electrical Examination	581
X.	Examination (*Cont.*): Reflexes	589
XI.	Diagnosis: Differential Diagnosis	592
XII.	Diagnosis (*Cont.*): Signs of Severe Nerve Injury	599
XIII.	Diagnosis (*Cont.*): Recovery of Function	605
XIV.	Development and Structure of the Peripheral Nervous System	620

		Vol. XVI
XV.	Pathology of Peripheral Nerve Lesions	141
XVI.	Histopathology of Nerve Degeneration and Regeneration	156
XVII.	Indications for Surgical Treatment	173
XVIII.	Methods of Nerve Repair	181

Chapter XIX

SURGICAL TECHNIQUE OF NERVE OPERATIONS

To repair peripheral nerve lesions, it is essential primarily that the surgeon have a practical knowledge of the anatomy of the peripheral nerves and to understand thoroughly the principles of nerve degeneration and regeneration. One must be familiar not only with the general anatomical course of nerve trunks, but also with the origin and distribution of the various branches. In addition, one must have a knowledge of the muscles supplied by the nerve to be repaired. These matters will be considered in later chapters and are concerned now with the technical steps of the surgical procedures commonly employed.

Preparation of the Operative Field

The skin of the extremity to be operated upon should be sterilized carefully well above and below the proposed limits of the incision. This is necessary because the original incision may have to be extended during the operation. Our practice is to wash the entire extremity thoroughly with soap and water before operation. In the immediate preparation of the field of operation we use ether, iodine and alcohol. Of course, the use of antiseptic solutions is a matter of choice for the surgeon. In the repair of nerve injuries during warfare, the use of transplants to repair the large defects in nerve continuity is more common than in civil life. Under such circumstances it is a wise practice to prepare the field from which the transplant is to be taken at the same time.

It is important to arrange the operative sheetings so that the entire extremity is exposed freely. Then it may be observed and manipulated without contamination of the surgical field. As in all operative procedures we feel that the surgeon himself should drape the extremity, since he should have a better

grasp of the problems which may be encountered than have his assistants. That part of the extremity beyond the operative field may be covered with sterile stockinette or in the case of the hand a sterile rubber glove may be put on. It is essential to be able to observe all muscle movements which may be produced by stimulation of the nerve trunk and to be able to move the extremity into any desired position during the operation.

The limb must be placed in a position which will afford the simplest approach to the operative field. These positions vary with the nerve to be operated upon and the site of exposure. Those found to be convenient in our hands have been described under each individual nerve. These postures should be maintained by the judicious use of sandbags or other mechanical apparatus so that an assistant's hands are not so occupied.

Anesthesia

The question of the type of anesthesia to be used in peripheral nerve surgery is an important one. Usually the operations are long and tedious. Above all, the surgeon should not feel under the strain of a necessity to hurry through. However, the choice of an anesthesia cannot lie solely with the surgeon. It is, of course, well recognized that some patients are psychically unsuited for local anesthesia though its administration be perfect. The task of lying quiet upon an operating table, though free from pain, is impossible for some individuals. Consequently, we feel that here as elsewhere in surgery judgment should be used in the choice of an anesthetic. In civil practice we have employed local anesthesia equally as often as we have ether, nitrous oxide-oxygen or ethylene general anesthesia. If a general anesthetic is given, it should be administered by a trained anesthetist who is capable of maintaining an even, light anesthesia.

To produce local anesthesia it is our custom to use ½ per cent novocaine solution to each ounce of which 10 minims of 1–1000 adrenalin chloride are added. It is essential to produce a line of intradermal wheals along the proposed line of incision.

The subcutaneous tissues may then be infiltrated. It may be somewhat difficult to introduce the solution into the dense scar tissue which may be present. Commonly it is not necessary to inject the nerve trunk directly until the ends are sectioned for approximation. One must remember that while the field may be quite bloodless during the operation, the constrictor effect of the adrenalin may soon disappear and unless careful attention is paid to hemostasis the wound will become quite wet from oozing vessels.

Exposure of the Lesion

The importance of long incisions which will afford an adequate exposure of the nerve lesion cannot be emphasized too strongly. By this it is meant that the incision should extend well above and below the probable site of injury. In other words, the incision must uncover the normal nerve trunk above and below the lesion. It should be a principle never to attempt to find the divided nerve ends in the dense scar tissue which is usually present at the site of the lesion. The contraction of the scar, the bulbous neuroma on the central end of the nerve, the distorted appearance of the peripheral end and the change of the normal anatomical relations will all serve to make identification difficult. The surgeon should expose the normal nerve trunk and then dissect it toward the lesion from above and below. It may then be followed with comparative ease through the scar tissue. If this rule is always followed, the chance of injuring the nerve trunk near the point of injury by mistaking it for scar tissue may be avoided.

During the exposure of the nerve trunk, it must be kept in mind constantly that the further formation of scar tissue must be guarded against. This may be done to a large degree by handling the tissues carefully, insuring complete hemostasis and maintaining a sterile field at all times. A careful clean-cut dissection confined as nearly as possible to normal lines of cleavage should be used. Bleeding vessels should be grasped individually and not in the center of a mass of tissue which

surrounds them. Only the larger vessels which cannot be controlled by crushing should be ligated and then the very finest of plain catgut should be used. Finger dissections should be

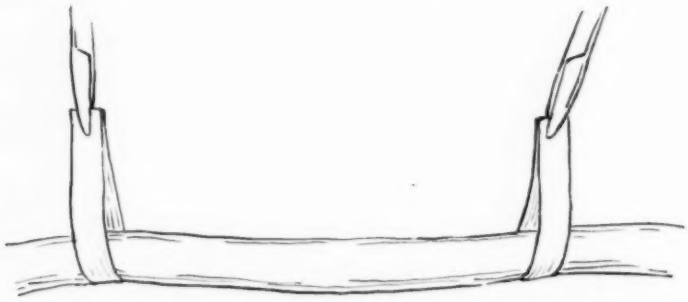


FIG. 110. Use of moist tapes to handle nerve trunk.

scrupulously avoided; in fact, there are no reasons why the fingers of the surgeon or his assistants should enter the wound. Sponging should be done with gauze or cotton pledgelets moistened in normal saline solution. After the nerve has been exposed it should be protected at all times by wet cotton sponges.

If it is necessary to handle the nerve during its exposure it should be done as gently as possible. It has been quite advantageous many times to pass a narrow moistened cotton tape beneath the nerve and to handle it in that manner (Fig. 110). After the ends have been freed from the scar tissue in which they are bound, the nerve may then be handled by its neuromatous ends. It is apparent how essential it is to be familiar with all of the branches of the nerve so as to avoid severing or injuring them during this exposure.

After the nerve and its neuromatous ends have been isolated and freed and before an attempt is made at approximation the surgeon should make certain that the field of operation is bloodless. We have on many occasions used a tourniquet to control bleeding. In our hands the most practical method of constriction has been to use a blood pressure cuff. However, we have had an occasional drop in blood pressure upon release of the constriction and are familiar with other instances in

which the patient went into profound shock immediately after this procedure. In addition, at times we have felt somewhat uneasy at the task of securing hemostasis after the suture line had been completed. Consequently, we have dispensed with the routine use of the tourniquet.

It also may be advisable at this stage to make preparations for the bed in which the sutured nerve is to lie. As has been stated, the most favorable condition is to place the sutured nerve upon the uninjured belly of a muscle or between muscle planes of cleavage. In large destructive wounds with a large amount of scar tissue this is often impossible so that recourse must be had to other methods which will be described later. Yet, at this time, surrounding scar tissue may be handled so that there may be the minimal possibilities of endangering the suture line. The nerve ends should be laid upon wet cotton pledgelets and the surrounding tissues so protected during the approximation.

Technique of Approximation

As soon as the normal nerve trunk has been identified above and below the lesion and before it has been handled in the slightest, a single silk suture should be placed through the epineurium exactly in the midline (Fig. 111). This will prevent accidental torsion of the nerve from its normal axis. As has been stated, it is very important to obtain an approximation of the nerve ends in as nearly the normal funicular apposition as is possible. This is more important in dealing with the peripheral end of the nerve where degeneration will have made it impossible to identify the normal funicular topography either grossly or by electrical stimulation.

The next step is to freshen the nerve ends by sectioning the neuromas until the bulging funicular bundles may be seen. With a sharp safety razor blade the neuroma on the central end should be sectioned successively at intervals of a millimeter until the dense scar tissue has been passed and normal

nerve structure is identified (Fig. 112). The hard, gritty sensation of cutting through the neuroma is quite in contrast to that experienced when normal nerve tissue is encountered.

FIG. 111. Use of identification sutures to prevent torsion of nerve.

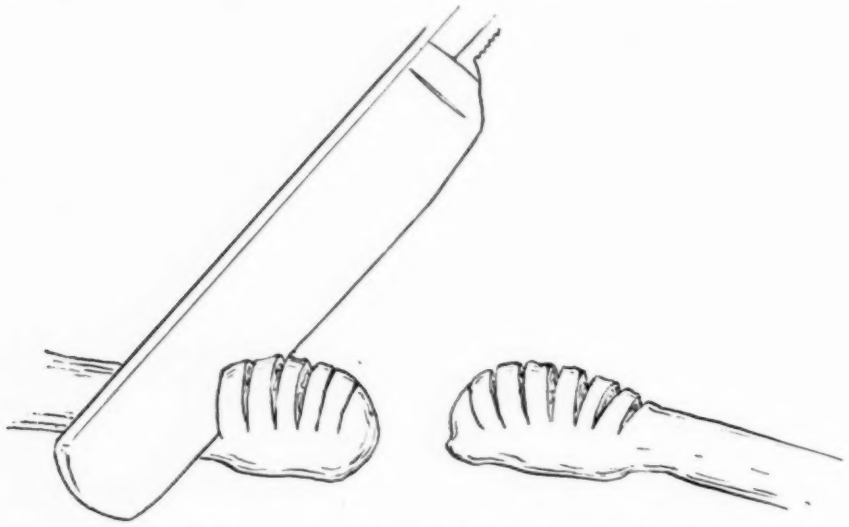


FIG. 112. Section of neuroma with razor blade until normal funiculi are found.

FIG. 113. Gross appearance of normal end of a divided nerve.

This procedure must be continued until the neuroma has been passed completely. The fresh normal nerve end is soft and resembles the end of a cut telephone wire cable with its bundles of nerve fibers bulging out beyond the end of the nerve sheath (Fig. 113). This latter characteristic appearance is not present at the end of the distal segment but one may rely upon the gross

disappearance of the presence of scar tissue. Regardless of how much one increases the gap between the ends of the nerves this step must be carried out thoroughly. The presence of scar tissue in the nerve ends will interfere seriously with the chances of obtaining a successful result. Very often after the neuroma has been sectioned from the central end, there will be bleeding from a small vessel in the epineurium. This may be controlled usually by a warm pledget of cotton but occasionally it is necessary to crush the vessel with a fine mosquito hemostat.

The field is now ready for the actual approximation of the nerve ends. We will describe the methods of apposition in the presence of large gaps later. The sutures placed through the nerve sheath to prevent torsion should be held in the position in which they were placed. The first suture of fine silk is placed through the epineurium only of the central and distal segments. It is important that this suture should not pass between or in any way constrict the nerve funiculi. Similar sutures should be passed in the medial, lateral and posterior quadrants of the nerve (Fig. 114). The posterior quadrant of the nerve trunk may be exposed by pulling the lateral quadrant suture to the medial side. By exerting simultaneous traction upon all four of these sutures the nerve ends are brought into approximation and then each suture is tied firmly but not so tightly that the ends of the nerve fibers are overlapped. The nerve ends should be brought into apposition without exerting tension. Intermediate sutures should then be placed in the nerve sheath around the circumference of the nerve trunk so that none of the nerve fibers gapes through the line of suture (Fig. 115). The sutures should then be cut off just as close to the knot as possible. We use fine silk suture material which is passed through vaselined gauze just before the suture is introduced. The finest Corticelli black silk is separated into its component strands and each of these serves as a suture. Sargent and Greenfield showed that although silk gives rise to a slight tissue reaction, chromic or other chemically treated catgut causes a marked tissue

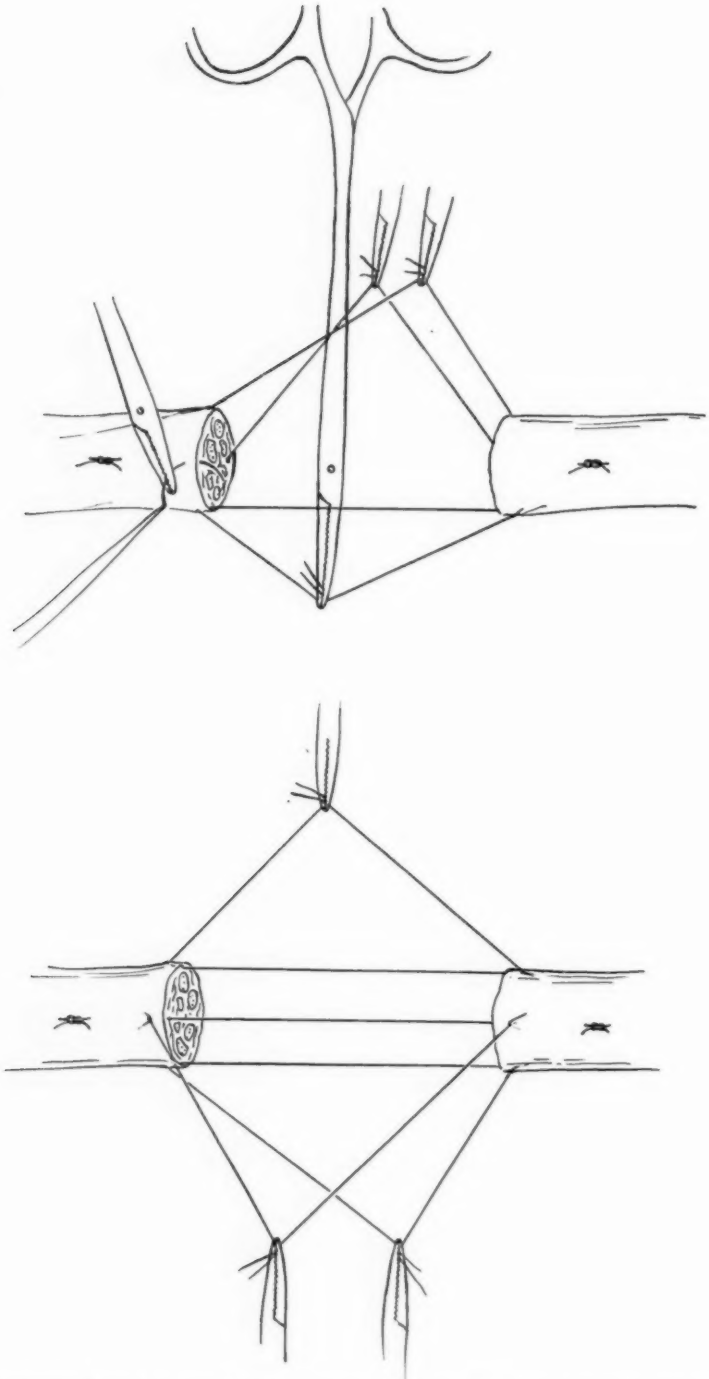


FIG. 114. Sutures placed in quadrants of nerve ends to facilitate accurate approximation.

reaction. It has also been shown that the tensile strength of silk is much greater than that of the finest catgut and yet the reaction of the tissues is less.

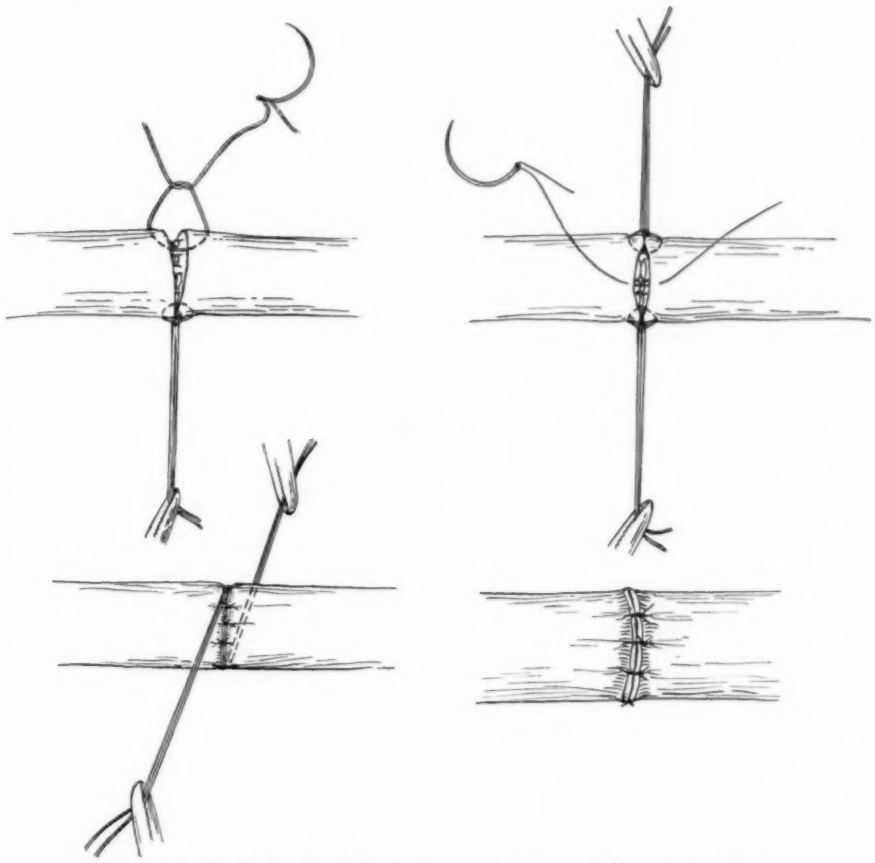


FIG. 115. Technique of obtaining an accurate end-to-end suture.

The united nerve should then be allowed to drop into its bed. As has been indicated, normal untraumatized muscle bellies are preferable as a protection for the sutured nerve. If there is a large amount of scar tissue present in the original bed adjacent normal muscle may be drawn together under the nerve. If this is not possible it may be feasible to place the nerve in a slightly different position without interfering with its function. If neither of these procedures is possible we find that a flap of superficial fat may usually be swung beneath

the suture line. Hemostasis in the field of operation should then be secured completely and the incision closed carefully in layers with fine suture materials.

Methods of Overcoming Large Defects

Very often a good approximation of the nerve ends without undue tension cannot be obtained easily because of the large gap which exists after the nerve ends have been prepared for suture. It becomes necessary to resort to various methods which will overcome these continuity defects.

Mobilization: The majority of the smaller continuity defects may be overcome by careful mobilization of the nerve trunk both below and above the lesion. This may mean only freeing the nerve from its normal bed between muscle bellies. It may be carried out for considerable distances from the lesion. The main point to be kept in mind is that no muscular branches should be destroyed. Occasionally these branches may be carefully dissected free so that their mobilization will add to that obtained in the nerve trunk. Gentle traction upon a mobilized nerve may be necessary and it has been shown that the result of a suture so performed may be entirely successful.

Changes in Joint Position: In a large number of cases the nerve ends may be approximated though a large defect be present by utilizing the relaxation of the nerve trunk obtained by changing the position of the governing joints. For example, flexion of the wrist will make it possible to approximate the ends of the median and ulnar nerves in the forearm though a large continuity defect be present. Likewise, the sciatic nerve is more relaxed with the leg in flexion (Fig. 116).

After the suture has been completed the joint must be kept in the position of relaxation. For this purpose we use a dressing of crinoline gauze. This material is starched and stiff but when wet thoroughly it may be used just as a plaster-of-Paris bandage. When the material dries, it again becomes firm and hard (Fig. 117). It will maintain the desired position adequately

and is less cumbersome and much more comfortable than a plaster splint. Later it may be split and removed as a shell so that the skin sutures may be removed. It should be replaced

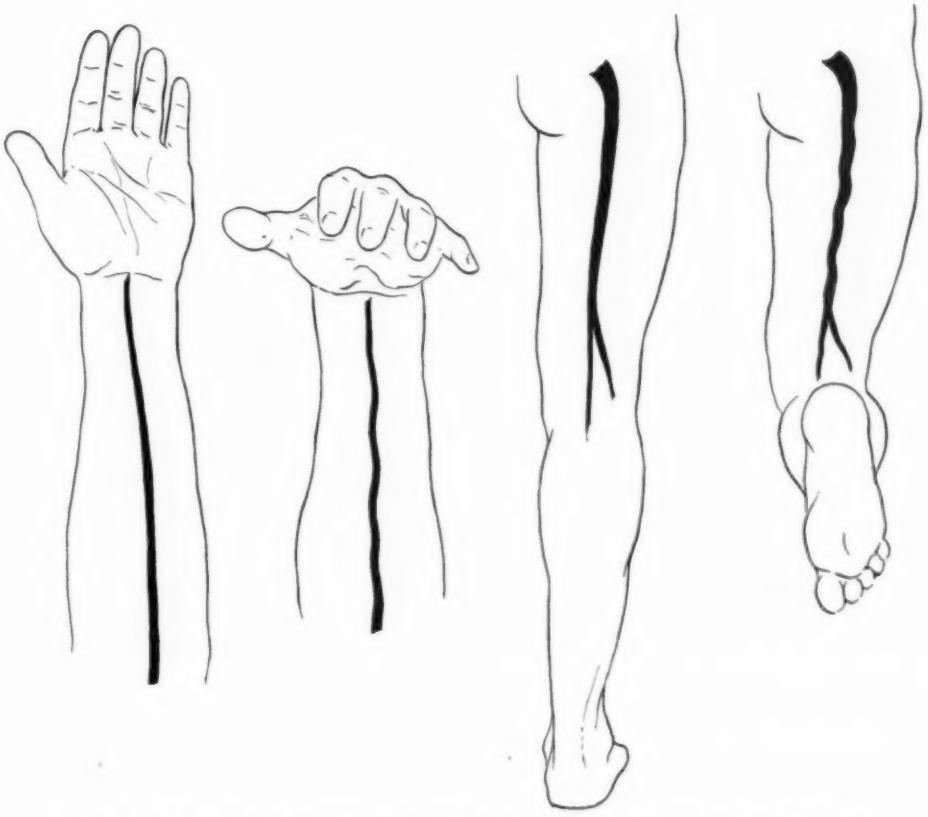


FIG. 116. Relaxation of sciatic and median nerves with leg and wrist in flexion.

so that the extremity is kept in the original position for at least two weeks. After that time we apply a light restraining dressing which will allow the joint to move and yet which will prevent any sudden change of position which might injure the suture line. Miller and Lewis have shown that after two weeks a nerve suture has almost reached its maximal tensile strength. Practically after that period of immobilization, the patient voluntarily graduates the degree of movement more satisfactorily than we can direct.

NERVE TRANSPOSITION: In the arm particularly, the anatomical course of the nerves may be shortened considerably by transposition from the dorsal to the ventral surface. This

FIG. 117. Use of a crinoline dressing to maintain elbow in flexion after suture of median nerve.

procedure requires a complete familiarity with the various branches given off from the nerve at its various levels so that they may not be sacrificed inadvertently.

No branches are given off by the ulnar nerve in the arm. At a point some 2 or 3 inches above the medial condyle of the humerus, it perforates the internal intermuscular septum to pass behind the condyle in the olecranon groove. Below the condyle it gives off its branches to the flexor carpi ulnaris and the inner heads of the flexor profundus digitorum muscles. It is possible to gain several inches by transposition of the nerve at the elbow from behind the condyle to the flexor surface of the elbow (Fig. 118). It is necessary, of course, to free the nerve well above and below. It is also possible to dissect the branches and

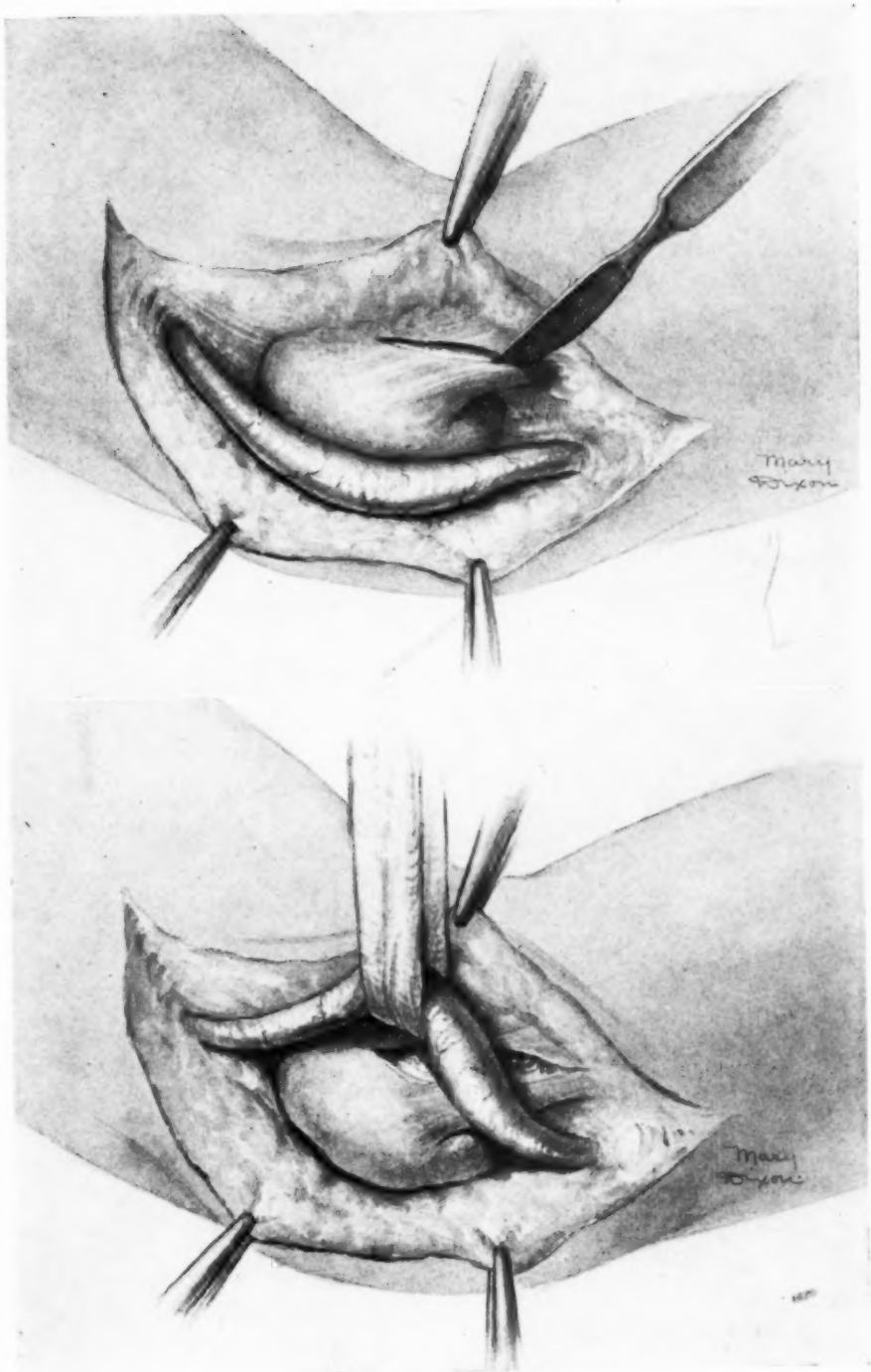


FIG. 118 A & B.

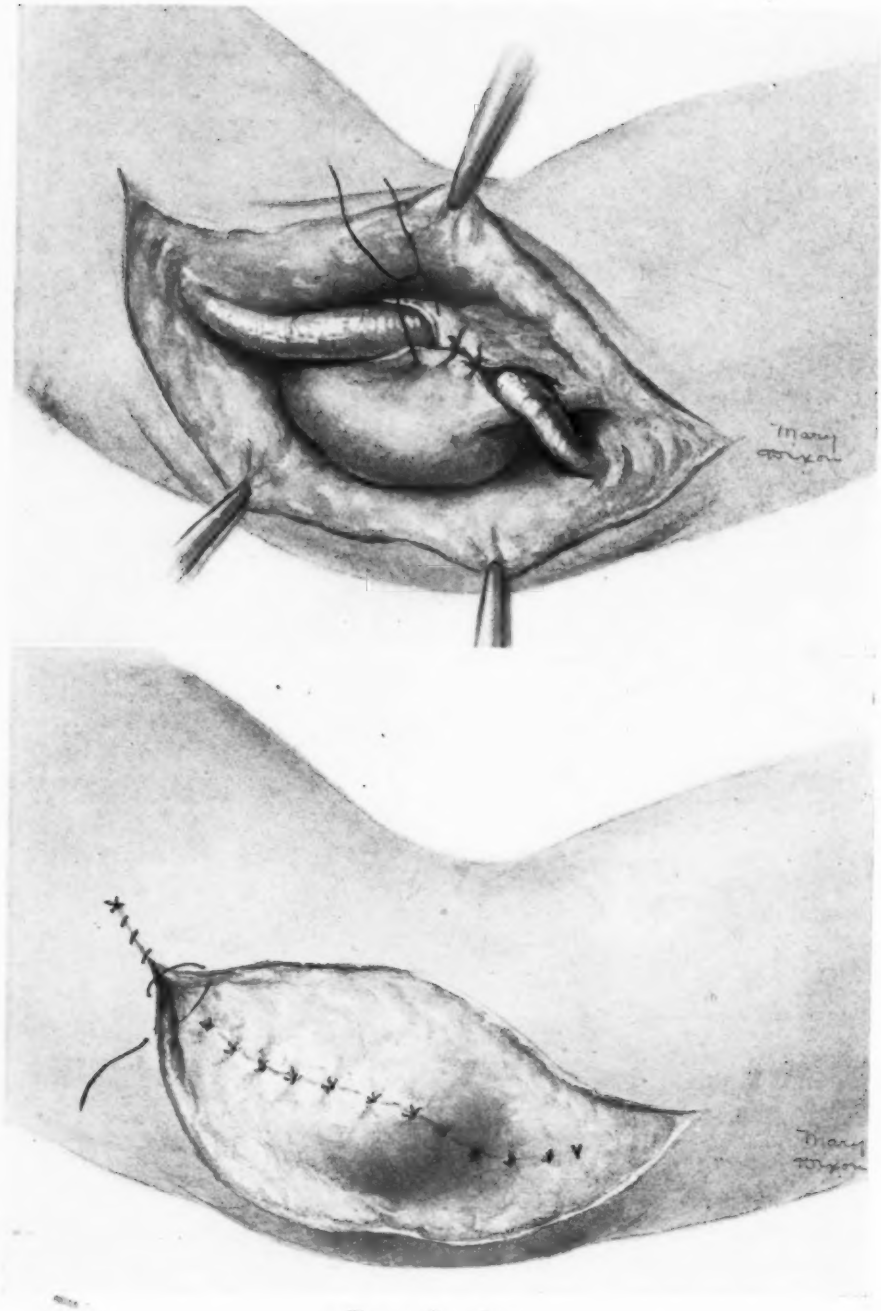


FIG. 118 C & D.

FIG. 118. Transposition of ulnar nerve from olecranon groove to flexor surface of elbow.

thus gain more freedom of the nerve trunk. The nerve may then be placed superficially although it may become quite tender because of its superficial position. It is perhaps more satisfactory, though more complicated, to place the nerve beneath the deep fascia and muscles. To accomplish this it is necessary to divide the pronator radii teres and superficial flexor muscles close to their origins from the medial condyle. The ulnar is placed beneath the reflected muscles which are then sutured back into place.

In many instances transposition of the radial nerve to a position anterior to the humerus is necessary because of the extensive scar tissue which involves the triceps muscle and the posterior surface of the humerus. It may also be used as a method to bridge a defect if the lesion is at another level. Two incisions are necessary to accomplish this transposition. The nerve should be exposed by an incision on the lateral side of the lower half of the arm. It should extend downward in the bend of the elbow to the medial side of the lateral condyle of the humerus. The other incisions should be made over the brachial artery in the upper half of the arm. Here the radial nerve is exposed at the lower border of the teres major muscle where it passes posterior to the humerus. The nerve is brought out of its groove on the humerus and is passed posteriorly and to the lateral side of the axillary vessels and the median and ulnar nerves. The biceps muscle is freed so that the nerve may lie in an oblique position beneath it. The nerve then runs directly from the axilla in front of the humerus to the outer side of the ventral aspect of the elbow. Through the lower incision alone it is possible to follow and mobilize the lower half of the radial well up along the groove in the humerus. This procedure permits of a large amount of gain in length.

The median nerve has a more direct course but some lengthening may be obtained by freeing the muscular branches in the forearm and transposing the nerve to a more superficial position.

In the lower extremity the course of the sciatic and its two terminal divisions are such that little gain can be obtained by transposition.

Two-stage Stretching Operation: In some cases the defect to be bridged before end-to-end suture is possible may be so great that none of these methods will suffice. Under such conditions the central and distal ends should be mobilized as much as possible; the neighboring joints should be placed in position to afford the greatest relaxation possible and if necessary transposition should be done. Then the neuromas should be sutured together. After a week's interval the position of the extremity is gradually changed so that the nerve trunk is gradually lengthened by stretching. When the extremity has been fully extended, the second operation is performed. The neuromas are resected and approximation is obtained. It may be necessary again to employ flexion-relaxation of the joints as in a one-stage operation. Experimentally there is no evidence that the regeneration which follows such stretching is any the less successful because of it.

Babcock and Spear state that based upon 160 cases of nerve suture the following continuity defects may be bridged and end-to-end suture obtained by use of one or all of the methods just described:

	Cm.
Cords of the brachial plexus	7
Ulnar nerve in the arm	13
Ulnar nerve in the forearm	13
Ulnar nerve in the forearm without transposition	5
Median nerve in the arm	12
Median nerve in the forearm without transposition	8
Median nerve in the forearm with transposition	13
Radial nerve in the arm	12
Musculocutaneous nerve in the arm	7
Sciatic nerve	12
Peroneal nerve	10
Tibial nerve	7

Technique of Nerve Crossing

The technique of approximation in a complete nerve crossing is exactly similar to that described for an end-to-end

suture. The distal end of the nerve trunk to be united is brought parallel to the normal nerve to determine the point at which the latter is to be divided. This point should be chosen carefully so that the suture may be performed without undue tension and so that no angulation results. It may be necessary to resect the neuroma upon the central end of the injured nerve and then to inject it with alcohol to relieve the patient of a painful neuroma. The distal end of the normal nerve used for the crossing will, of course, degenerate.

If a partial nerve crossing operation has been decided upon, the level and size of the segment to be raised should be determined. Two silk sutures are placed in the epineurium and a longitudinal incision the requisite length is made upward in the normal nerve. This incision should be made, if possible, between the funiculi and not through them. This segment is then divided transversely from within outward to avoid further injury to the remainder of the normal nerve trunk. The approximation to the distal end of the injured nerve is then made by silk sutures in the same manner as has been described previously.

Technique of Nerve Graft

The same careful attention to technique as has been described in an end-to-end suture must be observed in performing a nerve graft. The principles of such an operation have been described. The success of a graft operation depends upon the accuracy with which the ends of the grafts are approximated to the central and distal ends of the nerve. Incorrectly placed sutures, or those tied too tightly, may bring the lateral surfaces of the grafts in apposition to the ends. A sufficient number of grafts must be used to cover the entire cross-section area of the central and distal stumps. It is obvious that it is difficult to judge the success or failure of such a method when so much depends upon the individual technique of each surgeon.

Stookey has devised and described a technique which is simple and efficient. The injured nerve is freed from scar tissue, mobilized as much as is possible and its central and distal ends

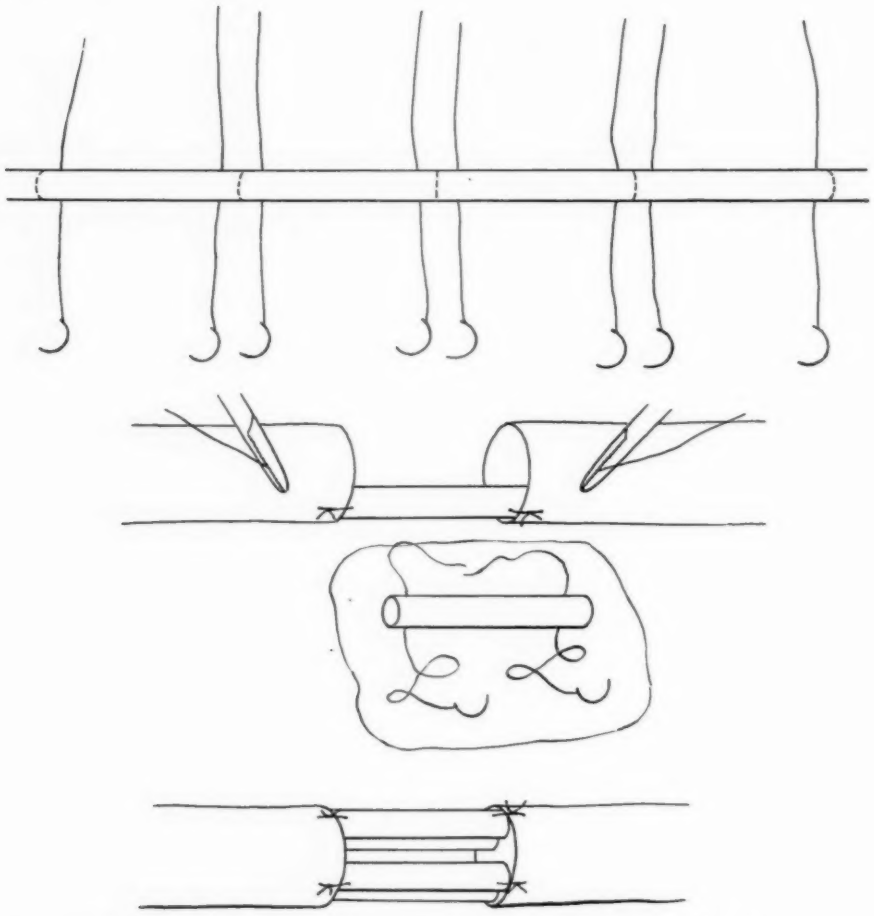


FIG. 119. Technique of nerve graft operation. (After Stookey.)

are prepared as in end-to-end suture. Alignment sutures to prevent torsion are placed in the upper and lower segments. The distance to be bridged is measured accurately. The nerve to be used for the grafts is then exposed and at intervals which correspond to the length of the grafts to be used, two silk sutures are placed. A small but sufficient interval is left between the sutures so that the segments may be divided. The sutures

are all placed in one direction so that the needles lie upon one side and the free ends on the other. Each segment is then placed upon a moist warm cotton pledgelet. This prevents

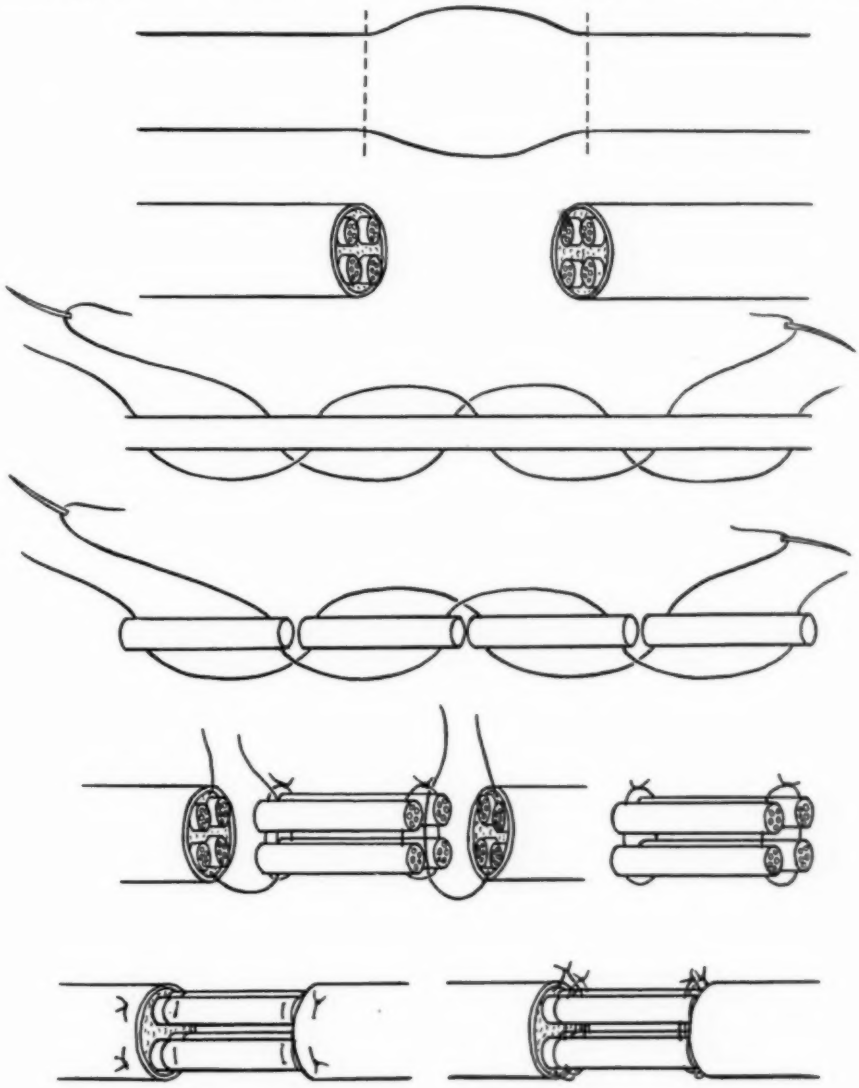


FIG. 120. Elsberg's method of nerve grafting.

handling the segments directly or with tissue forceps. Each segment may thus be placed into position on the cotton pad and sutured separately to the nerve, in whatever position is desired. (Fig. 119.)

Elsberg has described a technique of suturing which permits the approximation of the entire cable graft as a whole. His description of this method is as follows:

Let us say that the graft is to be 7 cms. long and is to consist of three strands. The one suture (A) is passed through near the attached upper end of the freed nerve, from the inner to the outer side of the nerve; a loop is left loose and the needle is then passed through the nerve from the outer to the inner side a little more than 7 cms. from the first point; again a loop is left, and the needle is passed through the nerve, from its inner to its outer side, at the same distance from the last point. The needle is then laid aside and a second needle and suture taken. This needle (B) is passed through the lower end of the nerve, from its outer to its inner side, a little more than 7 cms. from the point of emergence of needle A. A loop of the suture is left and the needle passed through the nerve, from the inner to the outer side, at a point 3 mms. above the point of emergence of suture A; finally, the needle is passed through the nerve, from its outer to its inner side, 3 mms. proximal to the next point above. The points at which the suture A has passed through the nerve correspond to the upper ends of the graft; and the points through which needle and suture B have been passed correspond to what are to be the lower ends of the strands. After the loops have been carefully arranged, the nerve is cut with fine scissors or a fine scalpel: (1) 1 mm. above the beginning of A, (2) 1 mm. below the beginning of B and (3) between each two points through which sutures A and B are passed apart in the nerve. An assistant then grasps the two ends of suture A and the operator the two ends of suture B. When traction is made, the strands are drawn together. Then each suture is loosely tied. A brings all of the upper ends of the strands together; B brings all the lower ends together. After the cable graft has thus been made, it is transferred to its place between the divided ends of the main nerve and sutured in position. [Fig. 120.]

Technique of Repair in Partial Nerve Lesions

Occasionally a nerve may be only partially injured as the result of a bullet or stab wound; from a surgical injury in debriding a wound, or removing a nerve tumor; or by a spicule of bone in a fracture. It is extremely important in the treatment of such lesions not to injure the nerve further in attempts at repair. If the nerve exhibits a central or lateral neuroma partial excision and approximation are indicated. The sheath

of the nerve trunk should be opened over a considerable length and the normal funiculi should be separated carefully from those involved in scar tissue. Those bundles which pass directly into the scar tissue should be isolated above and below the scar and stimulated with a weak faradic current. If this stimulus evokes a response it may be assumed that the bundle in question is anatomically intact and it should be freed carefully from the scar tissue. If, on the other hand, no response occurs, the infiltrated area must be resected and the ends approximated by a suture passed directly through the bundle. It may be necessary to remove a v-shaped portion of the sheath of the nerve to facilitate approximation of the bundle of fibers. The nerve sheath is either left open or only partially closed and the defect covered by an untraumatized muscle sheath or by a pedicled fat transplant. If a nerve trunk is not completely divided and retains only a small amount of functional integrity it is wiser to perform a complete section and an end-to-end suture.

Technique of Neurolysis

Attention has been called to the difficulty of making a diagnosis between complete physiological and complete anatomical lesions of nerve trunks. If a physiological lesion has been diagnosed and sufficient time has elapsed without evidences of spontaneous regeneration, surgical exploration is indicated.

External neurolysis consists in the complete exposure and removal of all scar tissue which may compress or strangulate the nerve trunk. After the nerve has been freed, if it is found to be soft and without any evidence of intraneural fibrosis, this procedure may be quite sufficient.

On the other hand, if the nerve is indurated and hard an internal neurolysis is indicated. The nerve sheath should be opened widely and held open by traction sutures. If the compression is due to a thickened and infiltrated nerve sheath and the bundles are quite normal in appearance this simple decom-

pression effect of opening the nerve sheath is all that is required. However, the funiculi may be matted together (Fig. 121). They must then be dissected free by separating them gently from

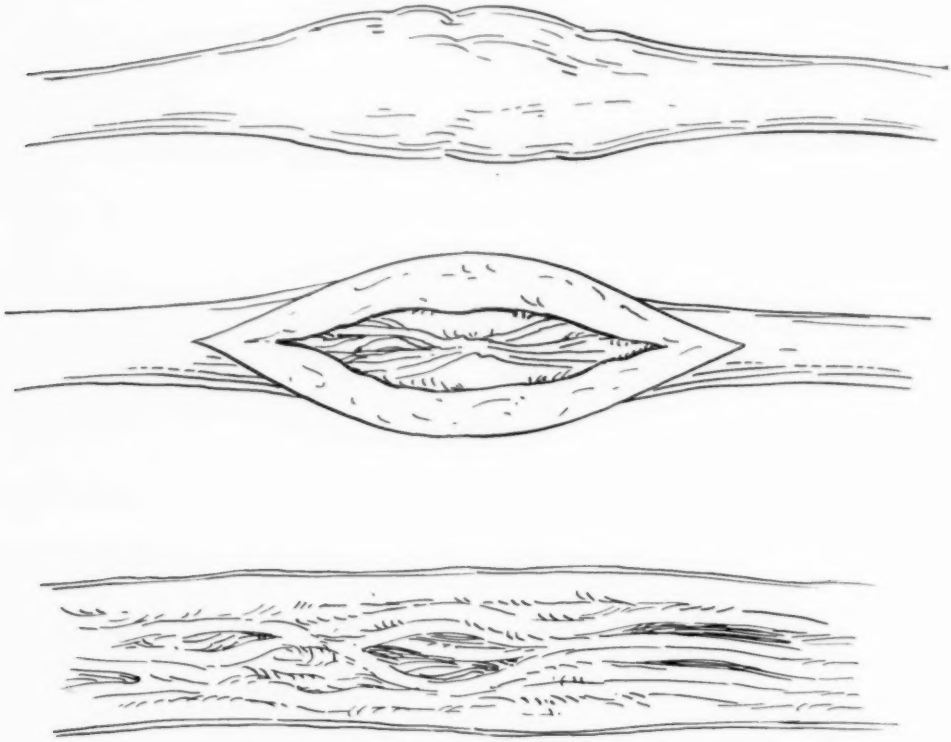


FIG. 121. Method of performing a neurolysis.

these fine intraneural adhesions. The density of this intraneural scar may be determined by the injection of warm normal saline solution into the nerve at the site of the lesion. In a normal nerve this procedure is followed by a fusiform swelling and separation of the funiculi. If the scar is dense the solution will not enter. The injection of the fluid not only determines the density of the scar but also breaks up fine adhesions which may exist. If this method is not sufficient the blades of a fine scissors may be introduced and spread gently between the funiculi. The presence of intraneural plexuses in normal nerve trunks must not be mistaken for adhesions. It is probable that if the

injection of salt solution is not sufficient to accomplish an internal neurolysis, any method of dissection regardless of the nicety of technique will be followed by more harm than good.

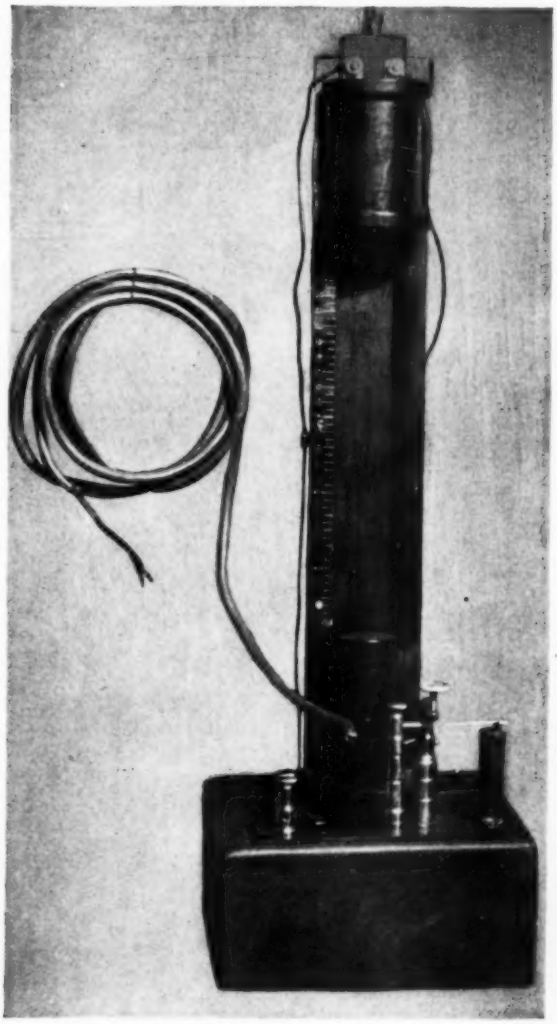


FIG. 122. Apparatus for stimulating nerves at operation. Electrode can be sterilized in an autoclave.

Under such conditions excision and end-to-end suture should be performed.

Electrical Examination of Nerves at Operation

An apparatus to stimulate the nerve trunk when it is exposed during the operation should always be at hand. All that is necessary is a dry cell, an inductorium, a make-and-break key and a stimulating electrode. The latter should be a fine-pointed bipolar electrode of copper or silver wires which may be sterilized. The ends of the electrode should be separated about 2mm. The weakest current possible should be used to begin the stimulation and this may be increased gradually by approximation of the secondary to the primary coil. Electrical stimulation is invaluable to determine the functional integrity of a nerve trunk or its component bundles. Too much emphasis cannot be placed upon the lack of surgical judgment used when the function of a nerve trunk is tested by pinching with a forceps or hemostat. It may be safely assumed that the response of muscles to a weak faradic stimulation of the nerve trunk above the lesion speaks against the seriousness of the suspected lesion (Fig. 122).

Chapter XX

POSTOPERATIVE TREATMENT

The after-treatment of patients who have had a peripheral nerve injury is equally as important as the operative procedure. It is not sufficient to expose a severed nerve and to suture it, unless one can enable the patient to return to a satisfactory social and economic position in life. This is not a fanciful ideal for which to strive. It may be accomplished in many instances, in spite of the neglect which many of these patients receive either because of their own carelessness or their doctor's lack of interest. It is of little value to have sutured a severed nerve and have regeneration of its fibers occur, if the effector mechanisms are shortened, contracted, fibrosed and ankylosed. To strive for a result which is the normal physiological function of the part involved should be the aim of treatment in these cases. This can be attained in the majority of cases by the help of *passive* and *active exercises*, *massage*, *electrotherapy* and *splints*, if these agencies are employed correctly and at the proper time.

Physical Therapy

As Langley has pointed out, intermittent passive or active stretching forces lymph, and so presumably metabolic products, from the muscles. This, of course, should be an advantage. Moreover, such active or passive movements have a distinct influence upon the formation of connective tissue. It is said that there is a visible increase of connective tissue in microscopic preparations of a muscle three weeks after section of its nerve. Part of the late contractures may be due to the shrinkage of this newly formed tissue which is soft and extensible. Active or passive movements of the denervated muscles will stretch the developing fibers so that when they do shrink there may be less tendency to a contracture. The cut ends

of a nerve may become rather fixed to the surrounding connective tissue so that movements may cause a greater pull upon the nerve. However, Langley has shown that in this pre-suture period the tension so placed upon a nerve is not sufficient to cause a rupture of the degenerating fibers.

In many operations it is necessary to fix the limb in a flexed position to permit the cut ends of the nerve to be brought into end-to-end apposition. In such instances passive movements designed to bring the limb into its normal position may be begun about two weeks after the suture has been made. Miller and Lewis have shown experimentally that the tensile strength of a suture line is as great at the end of that time as it is weeks later. This is an important fact which allows passive and active movements to be instituted before formidable ankyloses and contractures have occurred.

Passive exercises may be carried out very well in conjunction with massage. They help to stretch contractures which have already occurred and to prevent those which invariably occur in a denervated muscle. They also increase the range of motion in an already stiffened joint and help to keep a mobile joint active so that when the time comes it is ready to perform its part in an effector mechanism. Finally, such movements help to re-educate the muscles in performing normal movements. These exercises should be carried out slowly, gently and never with quick, jerky movements. Each separate passive exercise should be individualized and the patient should be required to make the attempt to perform the movement simultaneously or to attempt to hold the part in the position imposed upon it.

In many instances active exercises may be employed to great advantage. For example, a median or ulnar nerve lesion at the wrist does not affect the innervation of the long flexor muscles of the fingers and the wrist. Unfortunately, it is common to find the phalangeal and carpal joints ankylosed or the muscles atrophied simply from disuse. As Kanavel has pointed out, in practically every case of joint or muscle injury, passive

motion of the injured part with the help of the sound member, combined with voluntary exercises will accomplish a great deal toward the restoration of function if the patient has

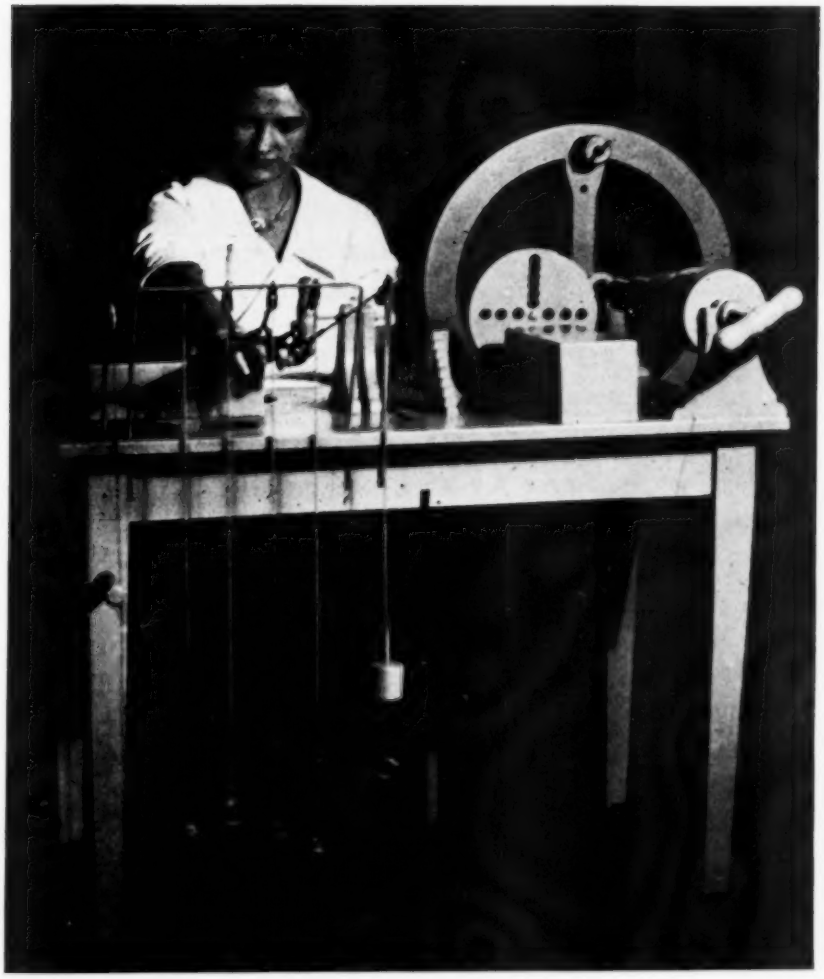


FIG. 123. Apparatus for exercising and stretching flexor tendons of fingers, for obtaining abduction and adduction of fingers and for developing other functions of hand and wrist.

sufficient intelligence and energy. Figure 123 illustrates a device for exercising and stretching the flexor tendons of the fingers, for obtaining abduction and adduction of the fingers and for developing other functions of the hand and wrist. The

wrist and forearm are strapped into position and the fingers are inserted into glove tips. Weights are added until the patient can just lift them, and as function improves heavier weights may be added. Games are of great value in effecting unconscious and effortless exercise of contracted muscles or ankylosed joints. Grasping a soft rubber ball to throw it, playing the piano or practicing on a typewriter are of particular value. For exercising the joints of the hand and wrist, hand ball, dumb bells and Indian clubs are also helpful. It must be recognized that most individuals require a definite goal to accomplish in each type of active or passive exercise instituted to maintain their enthusiasm during the long period of treatment which is necessary.

Before *massage* is begun the part should be exposed to heat for twenty to thirty minutes to obtain as much relaxation as is possible. Radiant heat, the infra-red light, hot packs or a whirlpool bath of warm water are all useful but should be used with extreme care, particularly because of the ease with which it is possible to burn the skin of a denervated area. The whirlpool bath is preferable because the motion of the water acts as a gentle massage which is pleasing to the patient and gives relief from pain.

Before beginning massage the extremity must be placed in a comfortable position with all of the muscles completely relaxed. The position of the extremity which is maintained by a splint should be held throughout the treatment. There never should be stretching upon the denervated muscles. Massage is begun with a period of rhythmic superficial stroking to obtain further relaxation. This may be given in either direction, whichever is more pleasing to the patient, and the pressure must be so gentle that even centrifugal stroking will not interfere with the circulation. Following this gentle stroking, all of the muscles of the extremity should be massaged with a centripetal motion to effect the venous and lymphatic circulation. More pressure should be used than previously but care should be taken not to injure the paralyzed muscles by compressing them

against the bones. This may be increased gradually until the massage consists of a gentle kneading.

With the extremity placed in the position of function the patient is directed to perform each normal movement of the paralyzed muscles. As the patient makes this attempt the extremity is passively carried through the complete normal range of the motion. As each normal movement is attempted the patient may be instructed to perform the same movement simultaneously in the normal limb. As the function returns the patient performs such part of the movement as is possible. The entire movement is completed as before by correlating the assistance in such a manner that there is no pause in the complete movement. The number of times each motion is repeated increases from two or three times at the beginning to eight or ten as function returns. Care should be taken never to cause fatigue. Gentle kneading and stroking should follow these movements.

If superficial scar tissue is present friction massage should be used. This is obtained by pressing deeply and moving the hand in a circular direction. The outer tissues should be moved over the underlying structures with a minimum of movement on the surface. If the scar is dry, a lubricant may be used at the end of the friction massage but its use in the beginning makes deep friction impossible. If adhesions and contractures are present, they must be stretched slowly and gradually. Stretching must not be carried to the point of causing pain or tenderness following the treatment and the return to the original position must be done as slowly and as carefully as the stretching movement. Gentle kneading of the contracted muscles and friction over the ankylosed joints may be performed during this procedure.

Electrotherapy

The indications for electrotherapy are to prevent atrophy of muscles and fibrosis, to increase nutrition, to conserve

the functional capacity of paralyzed muscles until sufficient nerve regeneration has taken place to permit of active motion.

The efficacy of this type of treatment has been called into

FIG. 124. Bristow coil for obtaining muscular contractions with faradic current.

question on a number of occasions. Although since the days of Duchenne neurologists have universally agreed that electrotherapy is of service in hastening the return of function of muscles paralyzed as the result of lesions of the lower motor neuron, some physiologists have decried its usefulness (Langley). On the other hand, many physiologists upon the basis of experimental studies have determined that there is a sound foundation for the belief that electrotherapy is serviceable in the treatment of peripheral nerve lesions. Not only have most of the workers found decreased atrophy in treated cases, but recently Piontkowsky has shown that a more advanced type of regeneration of the nerve occurs when the denervated extremity is treated by electrotherapy (Fig. 124).

It is necessary to understand clearly the mode of action of treatment by electricity. It is not concerned with any mysterious force acting directly upon the factors influencing recovery

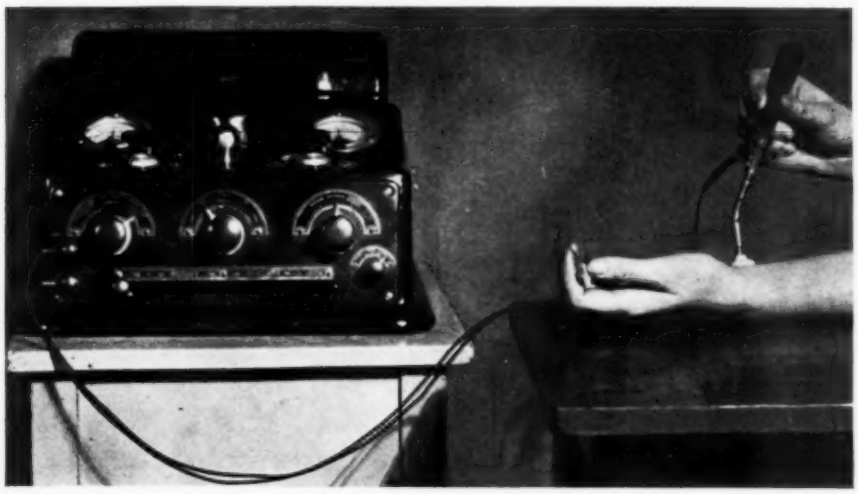


FIG. 125. Apparatus for obtaining muscular contractions with sinusoidal current.

of a nerve or muscle. Stimulation by an electric current of sufficient strength produces a contraction of the muscle. It is this active contraction of the muscle which conserves its bulk and nutrition and keeps the muscle fibers functionally adequate for voluntary movement when regeneration has progressed sufficiently. In cases such as facial nerve paralysis, contractures are diminished and associated movements so often of disfiguring and annoying consequence likewise are prevented. The only requirement of electrotherapy is that it produce a contraction of the paralyzed muscle. Obviously, this cannot be brought about by stimulation with the faradic current, as the duration of each shock is too short in relation to the changed chronaxia of the nerve and muscle. Galvanic current must, therefore, be used. It may be used in its simple form of a continuous current, or in the form of sinusoidal currents of various types of waves (Fig. 125).

It has been proposed that continuous current which at the make or break produces a sharp, shock-like contraction, is of

little value as it does not resemble a normal contraction of the muscle, which it is said is imitated by the contraction ensuing as the result of stimulation by the sinusoidal current. Of course, the criticism that it acts only locally may be met by the statement that larger electrodes should be used. That muscles contract slowly in their normal state has never been shown to be the case by physiologists. The twitch contraction due to electrical stimulation is thought to be analogous to the phasic contraction of all skeletal muscles. It may, we believe, be accepted as a fact that the contraction of a muscle resulting from stimulation by galvanic continuous current is as useful as that produced by any other type of galvanic current. The rapidity of the contractions can produce no harm after the second week following injury or surgical procedures, and during the first two weeks the muscles should be kept practically at rest, as they are fragile and are easily bruised. After this period sudden contractions are just as useful as slow ones. The force of the contraction can, of course, be modified by the strength of the current. Galvanic continuous stimulation is often painful; therefore, other types of waves are useful as they are relatively painless and can be used to advantage in children and sensitive patients. It is necessary to remember that the contraction of a muscle occurs only upon making and breaking the current. Therefore, it is needless to treat the muscle by prolonged stimulation and the current should be applied with very short makes and immediate breaks of the current by using a suitable electrode. The stimulation may be obtained by using bipolar or unipolar methods. In the former both poles are applied to the muscle which it is desired to stimulate. In the latter an indifferent electrode of a large size is placed elsewhere upon the body, as described under electrodiagnosis. During the first few months following injury, while the muscles are hyperirritable, and an increase of direct myotatic irritability may be demonstrated by percussion, unipolar stimulation will produce contraction in the muscles most effected by the weakest currents, because of longitudinal stimulation. Care must

be exercised, therefore, not to produce too great fatigue in these muscles. One must always keep in mind the fact that in many cases deep muscle sense is defective and the patient is unable to tell when the muscles are fatigued. After the first few months, the muscles most affected become less irritable and unipolar stimulation produces a spread of current to unparalyzed muscles, which alone may contract, to the injury of the patient. At this time bipolar stimulation is of greater value. A clear knowledge of anatomy and function of muscles is necessary to produce the most benefit. Particularly is this true of the small hand muscles. Inasmuch as the nerve itself is not irritable to stimulation, the electrodes need not be placed upon the motor points of the muscles, as is the case in paralysis of the upper motor neuron. However, even the muscle may contract more readily at these points.

Although polar inversion is not always the rule in degenerated muscles, it is sufficiently the case so that the positive pole should be used as the active electrode. This is also the least painful.

In producing contractions of the paralyzed muscles, care must be exercised to prevent the force of gravity acting against the contracting muscles, not only to prevent one from detecting movement of segments around the joints, but to prevent fatigue. Upon stimulating the extensors of the wrist no movement may be seen if the wrist is held dependent, whereas if it is supported upon a board at its ulnar border extension may take place. The extensors of the foot may not produce a movement with the extremity in a position of foot drop, but if the patient rests the leg on a board at the outer surface, dorsal flexion may occur. The patient's extremities must be fully supported and the segments about joints so supported that movement is not impeded by gravity.

Contractions of muscles produced by electric stimulation are a valuable adjunct to reeducation and active motion. Although the patient may not be able to produce extension at the wrist voluntarily, the hand may be held in this position

after electrically produced extension has occurred. A voluntary contraction of a muscle may be possible after it has been produced by electrical stimulation, and the patient should be required to attempt such a movement during the period of treatment. Of course, one should always keep in mind the law of regeneration. When it is remembered that the extent of regeneration of the nerve after section and suture is 1 mm. a day, it is futile to have the patient attempt active movement before the fourth month in such cases. In severe compressions recovering without operation but associated with complete degeneration of the distal segment, the same conditions hold true. Care must be exercised in treating areas of skin in which sensation has been destroyed, as burns are readily formed and when ulceration once occurs healing is difficult.

When the nerve and muscle have recovered sufficiently to contract to faradic stimulation both galvanic and faradic stimulation are advisable; the latter to produce more prolonged or tetanic contractions. An apparatus which permits of stimulation by gradual increase and diminution of current, such as is possible with a Bristow coil, is valuable as it is less painful. Here again it is necessary to state that during the period of severe degeneration the faradic current will not produce a contraction of the muscle, and no contraction means no treatment.

Sinusoidal current and other forms of wave currents have only the advantage of relative painlessness. There is a seeming advantage in the fact that at times a larger electrode is used and rhythmic contractions produced in large muscle groups. This is a disadvantage and care should be exercised to stimulate only the paretic muscles.

Splints

Just as the purpose of massage, exercises and electrotherapy is to maintain the nutrition of the denervated muscles, so the first aim of mechanical splints should be to prevent overstretching of the paralyzed muscles, to restrict shortening of

the normal antagonistic muscles and to maintain as nearly as possible the normal range of the joints and tendons of the affected extremity.

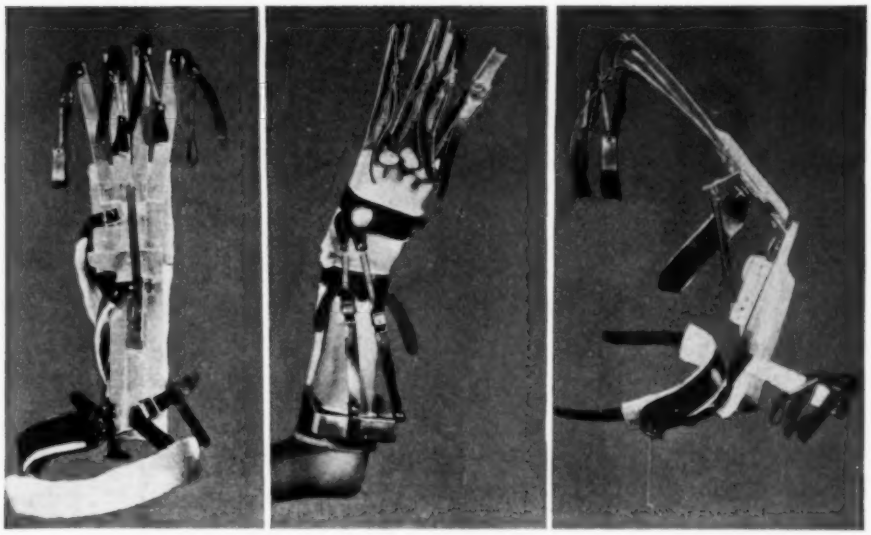


FIG. 126. Aluminum splint by which elastic traction may be obtained to overcome contractions of tendons and ankylosis of joints in neglected cases.

One cannot dogmatically recommend a single splint for each type of peripheral nerve injury. Each case is an individual problem and the splint should be devised to fit the patient and his injury. In general, the splints may be divided into the fixed or immobile and the mobile types. Both kinds of apparatus attempt to correct postural deformities and prevent overstretching of the muscles. In addition, the mobile splints aim to replace part of the movement lost. Necessarily they are more complicated and involved. The fixed splints are more simple and if their use is accompanied by intelligent physical therapy we believe they are more practical.

The ideal type of a splint should be light, simple, easily applied and removed, inexpensive and as inconspicuous as possible. We have found that splints made of aluminum are very practical. It is quite simple to change the character of these splints from time to time as recovery of function occurs.

It is, of course, quite wrong in many cases to use the original splint when the purposes for which it is required have changed with the improvement in muscle and joint function (Fig. 126).

The character of the splint required also depends greatly upon the time which has elapsed between the original injury and the institution of treatment. Because of loss of tissue it may be necessary to fix a joint in flexion or extension to obtain a direct end-to-end suture of the severed nerve. It is wise to remove a constant fixation splint as early as possible and replace it by a splint which may be removed temporarily to allow passive movements and other forms of physical therapy. We have found that a cast of starched crinoline is as efficient as a plaster cast and is much lighter and more comfortable for the patient during the period of constant immobilization.

If such a forced position is unnecessary, then the problem presented by the patient who appears for treatment shortly after the nerve injury may be met by a light efficient splint which relaxes the denervated muscles and prevents overstretching. At the same time shortening of the antagonistic muscles is prevented.

A more difficult and complicated problem is offered by the patient who comes for treatment long after the original injury and with fibrosed joints and stretched, atrophied muscles. A splint should be so devised as to maintain the part in as nearly as possible its normal position of function. Traction upon ankylosed extended phalangeal joints should be elastic and easily varied as conditions change. More specific statements about the types of splints we have found to be most useful may be made if we briefly consider each individual nerve injury and the deformity which accompanies it.

Ulnar Nerve Lesions: Paralysis of the ulnar nerve is easily recognized by the appearance of the hand, with clawing of the little and ring fingers, inability to grasp objects between the thumb and forefinger because of paralysis of the adductor pollicis, and inability to make a cone of the hand by approxi-

mating the tips of the fingers and thumb because of paralysis of the interossei. Lateral movement of the fingers is possible only through supplementary movement, and the patient is unable to innervate the muscles of the hypothenar eminence.

Although many devices have been constructed for the treatment of ulnar nerve lesions, in general, the majority of cases recover more completely without the use of these cumbersome appliances. They interfere with the motility of unparalyzed muscles which suffice to move all of the segments about the joints of the hand. The only disabling complication which follows ulnar nerve lesions is clawing of the little or little and ring fingers. Passive movement commonly suffices to prevent this. When it appears that clawing will result as a consequence of overaction of the extensor communis digitorum, a simple posterior splint for the little and ring fingers may be applied. Extension of the distal phalanges of the little and ring fingers may be defective because of overextension of the proximal phalanges, and a device which prevents these phalanges from overextending is useful in recovering lesions. A narrow strip of metal running diagonally across the palm from the base of the third to the base of the little finger, then bent to continue in the opposite direction over the dorsum of the proximal phalanges of the little, ring and middle fingers is often serviceable.

Median Nerve Lesions: Paralysis due to a lesion of the median nerve produces an inability to oppose the thumb to the little finger, to abduct the thumb at *right angles* to the palm, to flex the index finger as in making a fist or clasping the hands, and to flex the distal phalanx of the thumb.

For the most part, what is true of the ulnar is likewise true of the median nerve. There is but little clawing of the index or middle finger and flexor contracture of the index finger does not occur. The only troublesome complication is a shortening of the adductor of the thumb, and at times it is necessary to hold the thumb in abduction at right angles to the palm. A light, hollow aluminum ball between the index finger and thumb with the fingers semiflexed assists. A hollow cylinder will serve the same

purpose. Occasionally an apparatus which by means of a spring supplants the abduction of the thumb may be serviceable, although in general springs are unsatisfactory.

Combined ulnar and median nerve lesions, when complete, produce inability to perform any flexor movements of the fingers or hand. Under such a condition a simple anterior splint supporting the hand in a slightly flexed position suffices. Clawing occurs in all of the fingers and counter-pressure should be exerted against the dorsum of the proximal phalanges. The thumb should be fixed in a position of abduction at right angles to the plane of the palm.

Partial lesions of these two nerves are particularly liable to be complicated by adhesions, shortening and deformity, and require much more attention than complete lesions.

Radial Nerve Lesions: A lesion of the radial nerve at the most common site of injury in the middle of the arm is followed by paralysis of the long supinator, the extensors of the wrist, fingers and thumb. The triceps is partially affected but sufficient function always remains so that it is unnecessary to consider it in devising a splint.

Consequently, the main deformity is a wrist drop. It is necessary only to attempt to perform movement of the fingers and the thumb with the wrist in full flexion to realize how disabling this deformity may be. Without correction the extensors very quickly become overstretched so that even with a return of innervation they may be unable to act. A splint must therefore be one which prevents or corrects a wrist drop. Many complicated and rather cumbersome appliances have been described for these patients. However, a simple light apparatus which dorsiflexes the wrist to an angle of about 50 degrees, which also extends the metacarpophalangeal joints and abducts the thumb, is all that is necessary. A splint constructed of light spring steel wire which extends to the elbow and is applied to the volar surface of the forearm is quite efficient. Such a splint has been described by Buercki and was used extensively in the United States Army. It may be wise

to have a spring joint at the wrist instead of a fixed support so that voluntary flexion of the wrist may be possible. This is not only convenient but there are certain advantages to be

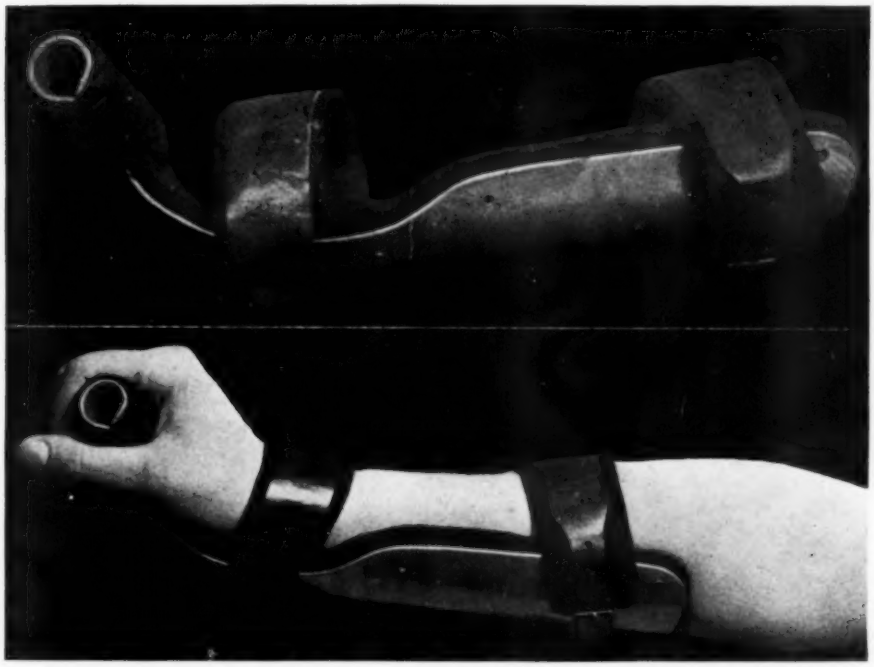


FIG. 127. Simple splint for overcoming wrist drop of radial nerve paralysis.

obtained for the passive recoil of the wrist to the extended position (Fig. 127).

MUSCULOCUTANEOUS NERVE LESIONS: Stookey has described a simple and efficient apparatus which may be used to aid in the treatment of lesions of this nerve. The important muscle which is paralyzed is the biceps. Fortunately, there is little or no likelihood of overstretching the biceps or of marked shortening of the triceps because of the mechanics of the elbow joint and the fact that other unaffected muscles act upon both the shoulder and elbow joints. However, at night a mechanical support which keeps the forearm flexed and the hand in full supination should be worn. Stookey's apparatus consists of a broad leather cuff attached to the wrist and dorsum of the

hand. The wristband has a metal plate which is shaped to fit the dorsum of the hand and wrist. Supination is maintained by a strap fastened to the wristband over the volar

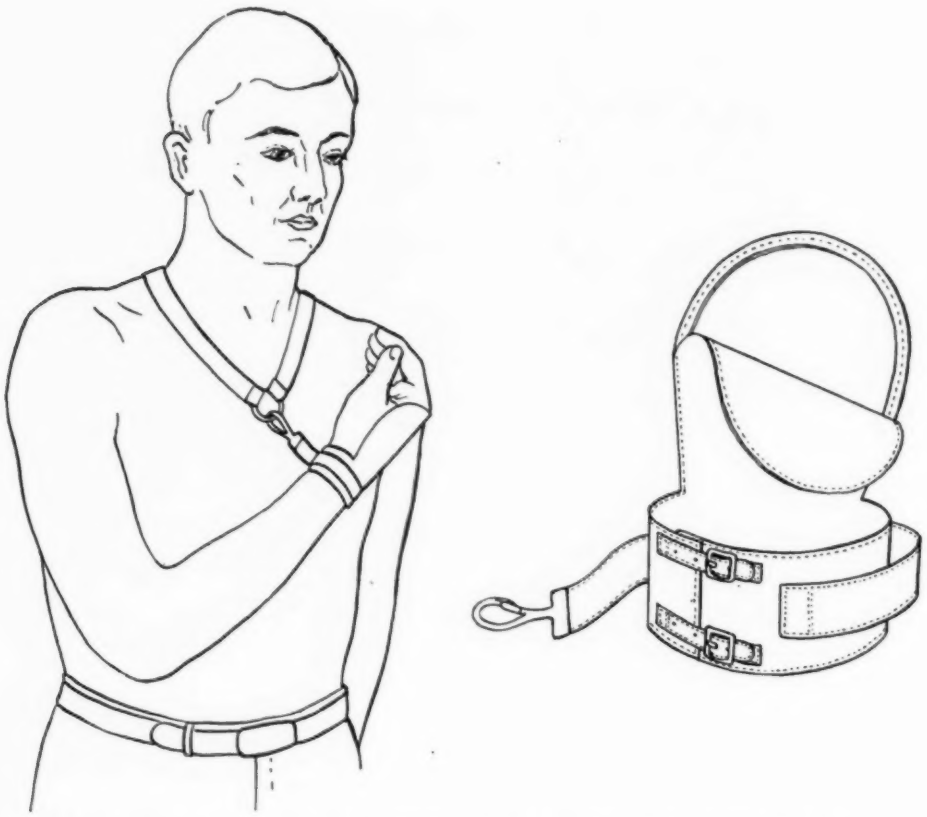


FIG. 128. Splint for use in musculocutaneous nerve lesions. (After Stookey.)

surface of the radius, which passes outward and under the wrist. This strap is then fastened to a collar piece by a pin or snap (Fig. 128).

BRACHIAL PLEXUS LESIONS: Of all of the peripheral nerve lesions none requires more constant and efficient mechanical treatment than those of the brachial plexus. This is true because the deformity is so extensive.

As has been pointed out previously, in general lesions above the clavicle are injuries of the roots and primary cords, whereas

those below the clavicle or in the axilla include the secondary cords and nerve trunks. These latter are frequently accompanied by injuries of the axillary blood vessels. There are two

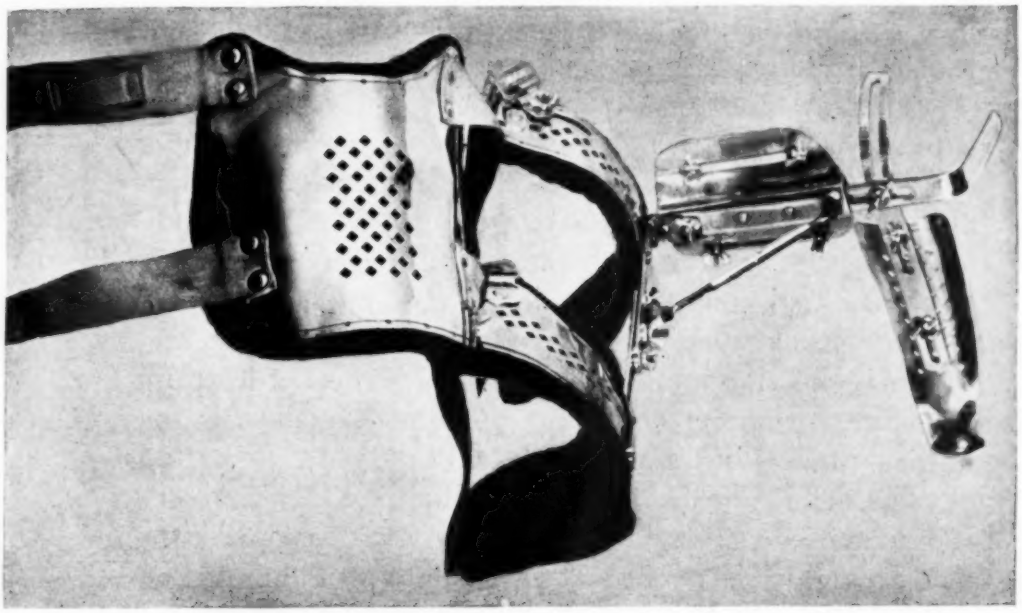


FIG. 129. Splint for use in brachial plexus paralysis to provide abduction of arm.

general types of supraclavicular injuries; the Erb-Duchenne or upper root group which involves the fifth and sixth cervical roots and the lower root group, or the Klumpke-Dejerine type, which involves the seventh, eighth cervical and first thoracic roots. In the former, the resulting paralysis is extensive and involves the muscles of the shoulder girdle and back as well as muscles of the arm and forearm. In the Klumpke-Dejerine type the paralysis is essentially of the ulnar side of the forearm and all of the muscles of the hand (Fig. 129).

In those lesions in which the muscles of the back (serratus magnus, rhomboids, levator anguli scapulae) are involved the deformity is extensive. The compensatory movements of the scapula are diminished or absent. The action of the serratus magnus in fixing the scapula so that the deltoid may act is gone and this must be kept in mind in devising mechanical support. The arm lies adducted with inward rotation. The

humerus may soon subluxate and in old neglected cases may be dislocated completely. The coracoid process becomes prominent and the forearm is held in semipronation. Because the entire extremity is rotated inward the palm of the hand may face backward. Left alone without mechanical support these lesions are followed by permanent and irreparable deformity.

A splint must be designed to relax the deltoid and the supraspinatus muscles and at the same time hold the arm in external rotation. The arm must be held in abduction, preferably at an angle of about 60 degrees, rather than in abduction at 90 degrees. The arm should be rotated externally and the forearm flexed upon the arm and held in moderate supination. Stookey has described a satisfactory splint for these cases. It is made of aluminum and consists of a chest, adjustable arm and forearm piece. The arm piece is hinged and may be adjusted to various angles of flexion.

The deformity present in the Klumpke-Dejerine, or lower root, type of paralysis is similar to that seen in combined median and ulnar nerve lesions. A slight straight splint on the volar surface of the forearm with grooves for each of the fingers proves quite satisfactory. The straps should be placed so that voluntary extension of the fingers is possible.

Sciatic Nerve Lesions: Paralysis of all of the muscles supplied by the sciatic nerve is uncommon even with a complete section of the nerve high in its course. The branches to the semitendinosis and long head of the biceps are given off at the level of the ischial tuberosities and consequently these muscles are spared. The semitendinosis alone is able to perform the functions of the hamstring muscles to a high degree. It is also able to supplement the action of the gastrocnemius in flexing the leg upon the thigh. (Fig. 130.) However, all of the muscles below the knee are paralyzed and the leg is flaccid, while the foot is dropped and in a valgus position. It is necessary to stabilize the leg and foot, to correct the equinovalgus deformity and to overcome faulty deviation of the body weight.

The most effective and comfortable splint is one based upon the Thomas caliper type (Fig. 131). It is light, comfort-

able and efficient. It should be so arranged with a spring lock at the knee joint that, while sitting, the knee may be flexed to an angle of 45 degrees. A sole plate should extent from the

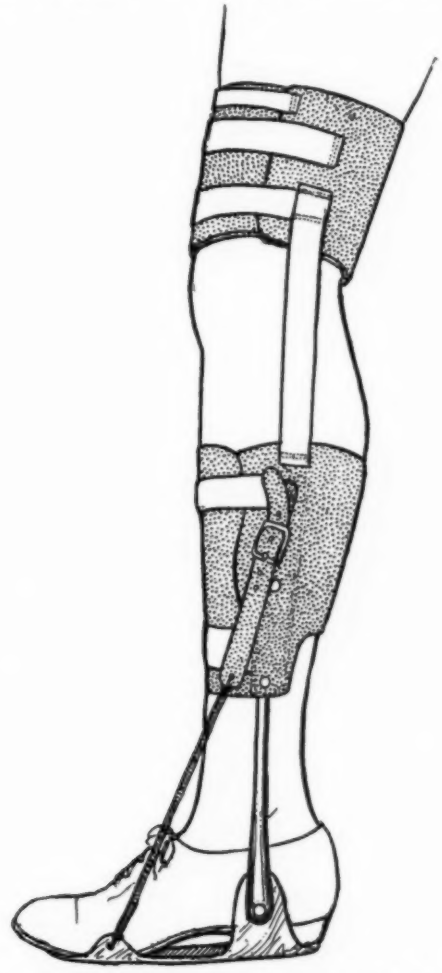


FIG. 130. Splint for use in sciatic nerve paralysis.

heel to the metatarso-phalangeal joint and should be attached to the upright so that the foot is held in dorsiflexion. The heel of the shoe should be raised on the inner side and the shoe reinforced there so that the valgus deformity will be corrected and at the same time the patient will bear his weight upon the outer side of the foot when he walks. This will aid the weakened arches which naturally accompany these lesions.

PERONEAL NERVE LESIONS: The deformity in these cases is one of foot drop and a varus deformity due to complete paralysis of the anterior and lateral muscles of the leg. The

FIG. 131. Thomas caliper type of splint for paralysis of lower extremity.

os calcis is raised considerably because of the unopposed action of the gastrocnemius. Flat foot occurs because of lack of support to the arches by paralysis of the peroneal group and extensors attached to the inner side of the foot. The gait is a very serious disability because of the overaction necessary to keep the toe from scraping the ground.

It is necessary to splint these patients for more than a toe

drop. A light iron strip on the inner side of the leg attached to the shoe with a stop lock will prevent a foot drop. It should be so attached that it raises the foot in dorsiflexion. The iron strip is attached above to a leather band about the leg. The leg should be elevated on the outer side from the heel to the toe to deviate the body weight to the inner side of the foot. This will correct the varus deformity. The ankle joint may be supported if necessary by a leather reinforcement sewed to the shoe. The flat foot may be corrected by an inside plate which should be made to fit individually by molding plaster casts of the foot deformity. The principal aim must be to correct all of the deformities and to prevent those which may result from the improper distribution of weight bearing. The patient should be cautioned never to walk without proper support of his foot. A rubber band or metal spring may be attached to the shoe and the upright to aid in replacing the lost action of the extensors (Fig. 132).

Tibial Nerve Lesions: The deformities present in these cases are practically the opposite of those described as the result of injuries of the peroneal. The unopposed action of the peroneal muscles pulls the foot into dorsiflexion and the os calcis is directed downward instead of backward. The foot tends to assume the valgus position and the longitudinal arch flattens because of the paralysis of the tibialis posterior and the small muscles of the sole of the foot.

Mechanical support may be given in the form of a light iron strip on the outer side of the leg attached to the sole of the shoe. This should have a stop lock which will prevent dorsiflexion to more than a right angle. The inner border of the sole and heel should be raised so as to deviate the body weight to the outer side and to correct the valgus position. As in the case of the peroneal deformities, an inside plate fitted individually should be worn to support the weakened arches.

The splints for these two latter types of deformities cannot be worn at night but their main action should be replaced by canvas appliances which will effectively prevent overstretching of the paralyzed muscles. Without the use of these nocturnal

supports all that has been accomplished during the day may be easily undone.

FEMORAL NERVE LESIONS: As has been stated, lesions of

FIG. 132. Two types of splints for correction of foot drop of peroneal nerve paralysis.

this nerve are accompanied commonly by injuries to the pelvic vessels and viscera. Consequently, one is not called upon frequently to provide mechanical support following such a lesion. However, the quadriceps femoris, sartorius and pectineus muscles are paralyzed and there is an inability to extend the leg upon the thigh. These patients are unable to stand upon their leg unless the knee is in extreme extension. The knee joint soon becomes so unstable that it may suddenly flex and allow the patient to fall. When walking, these patients usually bend forward and place their hand on the thigh to keep the knee joint securely extended. The tensor fascia lata may act to hold the joint in fixed extension and then the patient assumes a swinging gait. In old neglected cases a genu recurvatum may develop.

Mechanical treatment must provide stability to the knee joint and yet prevent hyperextension. A Thomas caliper splint with a spring lock which allows of flexion of the knee only while sitting is the most efficient type of splint. A broad band in the popliteal space will prevent hyperextension and the occurrence of genu recurvatum.

FACIAL NERVE LESIONS: The facial muscles must be protected from overstretching and sagging after interruption of their nerve supply just as are other muscles. The mechanical

FIG. 133. Simple elastic splint for the muscles of face in facial nerve paralysis.

support of these muscles contributes tremendously to the recovery of their action after a nerve supply has been reestablished. In neglected cases the muscles may become so stretched that an eversion of the lower eyelid may occur.

The simplest type of support consists of two adhesive straps. The point of pull should be attached to the temporal area. The supporting straps should be attached to the skin about the upper and lower lips. The ends of the two straps may be attached by a rubber band so that an elastic pull upward is maintained. This support must be worn constantly. It is simple and is easily detached during massage, electrotherapy and active exercises which are practiced by the patient. (Fig. 133.)

THIS MONTH'S CONTRIBUTORS

BANCROFT, FREDERIC W., M.D., F.A.C.S., N. Y.
Assoc. Prof. Clin. Surg., Columbia U.; Direc. of Surg., Fifth Ave. Hosp.

DAVIS, LOYAL, M.D., PH.D., F.A.C.S., Chicago.
Assoc. Prof. Surg., Northwestern U. Med. School; Attend. Neurol. Surg., Passavant Mem., Michael Reese & Wesley Mem. Hosp.

ERDMANN, JOHN F., M.D., F.A.C.S., N. Y.
Prof. Surg., Columbia U. (P. G. Dept.); Dir. of Surg., N. Y. Postgraduate Hosp.

FOSTER, GEORGE S., M.D., Manchester, N. H.
Surg., Lucy Hastings Hosp.; Author of "Health," Boston, 1932, and "Collected Papers," Clarke Press.

FRAZIER, CHARLES HARRISON, M.D., SC.D., F.A.C.S., Phila.
John Rhea Barton Prof. Surg., U. Penna.; Chief, Neurosurg. Serv., Univ. Hosp.

HAYES, HERBERT T., M.D., F.A.C.S., Houston.
Proctol., Herman, Jefferson Davis, Memorial, Methodist Hosp.

HUNNER, GUY L., M.D., SC.D., F.A.C.S., Balt.
Assoc. Prof., Clin. Gynec., Johns Hopkins Med. School.

KIRSCHENMANN, JOHN J., M.D., Brooklyn.
Assist. Surg., Norwegian Hosp.

LA ROQUE, G. PAUL, M.D., F.A.C.S., Richmond.
Prof. Clin. Surg., Med. Coll. Va.; Surg., Memorial, Retreat for Sick, Sheltering Arms, Dooley & St. Philip Hosp.

LEARMONTH, JAMES R., M.D., M.B., CH.B., CH.M., F.R.C.S. (Edin.), Rochester, Minn.
Assist. Prof. Surg., Mayo Found.; Assoc., Sect. Neurol. Surg., Mayo Clin.

PAYNE, ROBERT L., M.D., F.A.C.S., Norfolk.
Sr. Surg., Norfolk Protestant & St. Vincent's Hosp.

PEARSE, HERMAN E., M.D., Rochester, N. Y.
Assist. Prof. Surg., U. Rochester School of Med. & Dent.

POLLOCK, LEWIS J., M.D., F.A.C.S., Chicago.
Prof. Nerv. & Ment. Dis., Northwestern U. Med. School; Attend. Neurol., Passavant Mem., Michael Reese & Wesley Mem. Hosp.

ROGOFF, J. M., M.D., Cleveland.
Assoc. Prof. Exper. Med., Western Reserve U.

SHELLEY, HAROLD J., M.D., F.A.C.S., N. Y.
Assist. Attend. Surg., Knickerbocker & St. Luke's Hosp.

THEARLE, WILLIAM H., M.D., F.A.C.S., Los Angeles.
Cons. Thor. Surg., Veterans Hosp., San Fernando.

THOREK, MAX, M.D., Chicago.
Surg.-in-Chief, Amer. Hosp.; Attend. Surg., Cook Co. Hosp.; Translator of Krause's "Surgery of the Brain and Spinal Cord," Phila., 1912; Author of "Human Testis and Its Diseases," Phila., 1924, and "Surgical Errors and Safeguards," Phila., 1932.

THOREK, PHILIP, M.D., Chicago.
Inst. Chicago Inst. Surg.; Adjunct, Amer. Hosp.

TILTON, BENJAMIN T., M.D., F.A.C.S., N. Y.
Direc. Surg., Broad St. Hosp.; Cons. Surg., Lincoln & Manhattan State Hosp.

TROUTT, JAMES M., M.D., F.A.C.S., Hot Springs Nat. Park, Ark.
Maj., Med. Corps., U. S. A.; Chief, Surg. Serv., Army & Navy Gen. Hosp.

VASTOLA, A. P., M.D., F.A.C.S., Waterbury, Conn.
Attend. Surg., St. Mary's Hosp.

WATERWORTH, S. J., M.D., F.A.C.S., Clearfield, Pa.
Chief of Staff & Chief Surg., Clearfield Mem. Hosp.; Penna. Cancer Comm.; Cons., N. Y. C. R. R.; Surg., B. & O. R. R.

WEINSTEIN, SYDNEY D., M.D., Brooklyn.
Staff, Rectal Clin., U. & Bellevue Hosp. Med. Coll.; Assoc. in Proctol., Beth Moses Hosp.; Attend. Proctol., Home & Hosp. for Incurables; Chief, Rectal Clin., Beth Moses Hosp.

WERSHUB, LEONARD PAUL, M.D., N. Y.
Instruc. Urol., N. Y. Homeopathic Med. Coll. & Flower Hosp.; Assist. Attend. Urol., Flower Hosp.; Assist Visit. Urol., Sea View Hosp.